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THE COMING SLAVERY.

By HERBERT SPENCER.

THE kinship of pity to love is shown among other ways in this, that it idealizes its object. Sympathy with one in suffering suppresses, for the time being, remembrance of his transgressions. The feeling which vents itself in "poor fellow!" on seeing one in agony, excludes the thought of "bad fellow," which might at another time arise. Naturally, then, if the wretched are unknown or but vaguely known, all the demerits they may have are ignored; and thus it happens that when, as just now, the miseries of the poor are depicted, they are thought of as the miseries of the deserving poor, instead of being thought of, as in large measure they should be, as the miseries of the undeserving poor. Those whose hardships are set forth in pamphlets and proclaimed in sermons and speeches which echo throughout society are assumed to be all worthy souls, grievously wronged, and none of them are thought of as bearing the penalties of their own misdeeds.

On hailing a cab in a London street, it is surprising how generally the door is officiously opened by one who expects to get something for his trouble. The surprise lessens after counting the many loungers about tavern-doors, or after observing the quickness with which a street-performance, or procession, draws from neighboring slums and stable-yards a group of idlers. Seeing how numerous they are in every small area, it becomes manifest that tens of thousands of such swarm through London. "They have no work," you say. Say rather that

they either refuse work or quickly turn themselves out of it. They are simply good-for-nothings, who in one way or other live on the good-for-somethings—vagrants and sots, criminals and those on the way to crime, youths who are burdens on hard-worked parents, men who appropriate the wages of their wives, fellows who share the gains of prostitutes; and then, less visible and less numerous, there is a corresponding class of women.

Is it natural that happiness should be the lot of such? or is it natural that they should bring unhappiness on themselves and those connected with them? Is it not manifest that there must exist in our midst an immense amount of misery which is a normal result of misconduct and ought not to be dissociated from it? There is a notion, always more or less prevalent and just now vociferously expressed, that all social suffering is removable, and that it is the duty of somebody or other to remove it. Both these beliefs are false. To separate pain from ill-doing is to fight against the constitution of things, and will be followed by far more pain. Saving men from the natural penalties of reckless living eventually necessitates the infliction of artificial penalties in solitary cells, on tread-wheels, and by the lash. I suppose a dictum on which the current creed and the creed of science are at one may be considered to have as high an authority as can be found. Well, the command "if any would not work neither should he eat" is simply a Christian enunciation of that universal law of Nature under which life has reached its present height—the law that a creature not energetic enough to maintain itself must die; the sole difference being that the law which in the one case is to be artificially enforced is, in the other case, a natural necessity. And yet this particular tenet of their religion which science so manifestly justifies is the one which Christians seem least inclined to accept. The current assumption is that there should be no suffering, and that society is to blame for that which exists.

"But surely we are not without responsibilities, even when the suffering is that of the unworthy?"

If the meaning of the word "we" be so expanded as to include with ourselves our ancestors, and especially our ancestral legislators, I agree. I admit that those who made, and modified, and administered, the old poor-law, were responsible for producing an appalling amount of demoralization, which it will take more than one generation to remove. I admit, too, the partial responsibility of recent and present law-makers for regulations which have brought into being a permanent body of tramps, who ramble from union to union; and also their responsibility for maintaining a constant supply of felons by sending back convicts into society under such conditions that they are almost compelled again to commit crimes. Moreover, I admit that the philanthropic are not without their share of responsibility; since, while anxiously aiding the offspring of the unworthy, they do nothing for

the offspring of the worthy save burdening their parents by increased local rates. Nay, I even admit that these swarms of good-for-nothings, fostered and multiplied by public and private agencies, have, by sundry mischievous meddlings, been made to suffer more than they would otherwise have suffered. Are these the responsibilities meant? I suspect not.

But now, leaving the question of responsibilities, however conceived, and considering only the evil itself, what shall we say of its treatment? Let me begin with a fact.

A late uncle of mine, the Rev. Thomas Spencer, for some twenty years incumbent of Hinton Charterhouse, near Bath, no sooner entered on his parish duties than he proved himself anxious for the welfare of the poor, by establishing a school, a library, a clothing club, and land-allotments, besides building some model cottages. Moreover, up to 1833 he was a pauper's friend—always for the pauper against the overseer. There presently came, however, the debates on the poor-law, which impressed him with the evils of the system then in force. Though an ardent philanthropist, he was not a timid sentimentalist. The result was that, immediately the new poor-law was passed, he proceeded to carry out its provisions in his parish. Almost universal opposition was encountered by him; not the poor only being his opponents, but even the farmers on whom came the burden of heavy poor-rates. For, strange to say, their interests had become apparently identified with maintenance of this system which taxed them so largely. The explanation is, that there had grown up the practice of paying out of the rates a part of the wages of each farm-servant—"make-wages," as the sum was called. And though the farmers contributed most of the fund out of which "make-wages" were paid, yet, since all other rate-payers contributed, the farmers seemed to gain by the arrangement. My uncle, however, not easily deterred, faced all this opposition and enforced the law. The result was that in two years the rates were reduced from £700 a year to £200 a year, while the condition of the parish was greatly improved. "Those who had hitherto loitered at the corners of the streets, or at the doors of the beer-shops, had something else to do, and one after another they obtained employment"; so that, out of a population of eight hundred, only fifteen had to be sent as incapable paupers to the Bath Union Workhouse, in place of the one hundred who received out-door relief a short time before. If it be said that the £20 telescope which, a few years after, his parishioners presented to my uncle, marked only the gratitude of the rate-payers, then my reply is the fact that, when, some years later still, having killed himself by overwork, in pursuit of popular welfare, he was taken to Hinton to be buried, the procession which followed him to the grave included not the well-to-do only but the poor.

Several motives have prompted this brief narrative. One is the wish to prove that sympathy with the people and self-sacrificing efforts on their behalf do not necessarily imply approval of gratuitous aids. Another is the desire to show that benefit may result, not from multiplication of artificial appliances to mitigate distress, but, contrariwise, from diminution of them. And a further purpose I have in view is that of preparing the way for an analogy.

Under another form and in a different sphere, we are now yearly extending a system which is identical in nature with the system of "make-wages" under the old poor-law. Little as politicians recognize the fact, it is nevertheless demonstrable that these various public appliances for working-class comfort, which they are supplying at the cost of rate-payers, are intrinsically of the same nature as those which, in past times, treated the farmer's man as half-laborer and half-pauper. In either case the worker receives, in return for what he does, money wherewith to buy certain of the things he wants; while, to procure the rest of them for him, money is furnished out of a common fund raised by taxes. What matters it whether the things supplied by rate-payers for nothing, instead of by the employer in payment, are of this kind or that kind? the principle is the same. For sums received let us substitute the commodities and benefits purchased; and then see how the matter stands. In old poor-law times, the farmer gave for work done the equivalent, say of house-rent, bread, clothes, and fire; while the rate-payers practically supplied the man and his family with their shoes, tea, sugar, candles, a little bacon, etc. The division is, of course, arbitrary; but unquestionably the farmer and the rate-payers furnished these things between them. At the present time the artisan receives from his employer in wages the equivalent of the consumable commodities he wants; while from the public comes satisfaction for others of his needs and desires. At the cost of rate-payers he has in some cases, and will presently have in more, a house at less than its commercial value; for of course when, as in Liverpool, a municipality spends nearly £200,000 in pulling down and reconstructing low-class dwellings, and is about to spend as much again, the implication is that in some way the rate-payers supply the poor with more accommodation than the rents they pay would otherwise have brought. The artisan further receives from them, in schooling for his children, much more than he pays for; and there is every probability that he will presently receive it from them gratis. The rate-payers also satisfy what desire he may have for books and newspapers, and comfortable places to read them in. In some cases too, as in Manchester, gymnasia for his children of both sexes, as well as recreation-grounds, are provided. That is to say, he obtains, from a fund raised by local taxes, certain benefits beyond those which the sum received for his labor enables him to purchase. The sole difference, then, between this system and the old system of

"make-wages" is between the kinds of satisfactions obtained; and this difference does not in the least affect the nature of the arrangement.

Moreover, the two are pervaded by substantially the same illusion. In the one case, as in the other, what looks like a gratis benefit is not a gratis benefit. The amount which, under the old poor-law, the half-pauperized laborer received from the parish to eke out his weekly income was not really, as it appeared, a bonus, for it was accompanied by a substantially equivalent decrease of his wages, as was quickly proved when the system was abolished and the wages rose. Just so is it with these seeming boons received by working-people in towns. I do not refer only to the fact that they unawares pay in part through the raised rents of their dwellings (when they are not actual rate-payers); but I refer to the fact that the wages received by them are, like the wages of the farm-laborer, diminished by these public burdens falling on employers. Read the accounts coming of late from Lancashire concerning the cotton-strike, containing proofs, given by artisans themselves, that the margin of profit is so narrow that the less skillful manufacturers, as well as those with deficient capital, fail, and that the companies of co-operators who compete with them can rarely hold their own; and then consider what is the implication respecting wages. Among the costs of production have to be reckoned taxes, general and local. If, as in our large towns, the local rates now amount to one third of the rental or more—if the employer has to pay this, not on his private dwelling only, but on his business-premises, factories, warehouses, or the like, it results that the interest on his capital must be diminished by that amount, or the amount must be taken from the wages-fund, or partly one and partly the other. And if competition among capitalists in the same business and in other businesses has the effect of so keeping down interests that, while some gain, others lose, and not a few are ruined—if capital, not getting adequate interest, flows elsewhere and leaves labor unemployed—then it is manifest that the choice for the artisan under such conditions lies between diminished amount of work or diminished rate of payment for it. Moreover, for kindred reasons these local burdens raise the costs of the things he consumes. The charges made by distributors, too, are, on the average, determined by the current rates of interest on capital used in distributing businesses; and the extra costs of carrying on such businesses have to be paid for by extra prices. So that as in the past the rural worker lost in one way what he gained in another, so in the present does the urban worker; there being, too, in both cases, the loss entailed on him by the cost of administration and the waste accompanying it.

"But what has all this to do with 'the coming slavery'?" will perhaps be asked. Nothing directly, but a good deal indirectly, as we shall see after yet another preliminary section.

It is said that, when railways were first opened in Spain, peasants standing on the tracks were not unfrequently run over, and that the blame fell on the engine-drivers for not stopping, rural experiences having yielded no conception of the momentum of a large mass moving at a high velocity.

The incident is recalled to me on contemplating the ideas of the so-called "practical" politician, into whose mind there enters no thought of such a thing as political momentum, still less of a political momentum which, instead of diminishing or remaining constant, increases. The theory on which he daily proceeds is that the change caused by his measure will stop where he intends it to stop. He contemplates intently the things his act will achieve, but thinks little of the remoter issues of the movement his act sets up, and still less its collateral issues. When, in war-time, "food for powder" was to be provided by encouraging population—when Mr. Pitt said, "Let us make relief in cases where there are a number of children a matter of right and honor, instead of a ground for opprobrium and contempt"*—it was not expected that the poor-rates would be quadrupled in fifty years, that women with many bastards would be preferred as wives to modest women because of their incomes from the parish, and that hosts of rate-payers would be pulled down into the ranks of pauperism. Legislators who in 1833 voted £20,000 a year to aid in building school-houses never supposed that the step they then took would lead to forced contributions, local and general, now amounting to £6,000,000; they did not intend to establish the principle that A should be made responsible for educating B's offspring; they did not dream of a compulsion which should deprive poor widows of the help of their elder children; and still less did they dream that their successors, by requiring impoverished parents to apply to boards of guardians to pay the fees which school-boards would not remit, would initiate a habit of applying to boards of guardians and so cause pauperization.† Neither did those who in 1834 passed an act regulating the labor of women and children in certain factories imagine that the system they were beginning would end in the restriction and inspection of labor in all kinds of producing establishments where more than fifty people are employed; nor did they conceive that the inspection provided would grow to the extent of requiring that, before a "young person" is employed in a factory, authority must be given by a certifying surgeon, who, by personal examination (to which no limit is placed), has satisfied himself that there is no incapacitating disease or bodily infirmity, his verdict determining whether the "young person" shall earn wages or not.‡ Even less, as I say, does the politician who plumes himself on the practicalness of his aims conceive the indirect results that will

* Hansard's "Parliamentary History," xxxii, p. 710.

† "Fortnightly Review," January, 1884, p. 17.

‡ "Factories and Workshops Act," 41 and 42 Victoria, cap. 16.

follow the direct results of his measures. Thus, to take a case connected with one named above, it was not intended through the system of "payment by results" to do anything more than give teachers an efficient stimulus; it was not supposed that in numerous cases their health would give way under the stimulus; it was not expected that they would be led to adopt a cramming system and to put undue pressure on dull and weak children, often to their great injury; it was not foreseen that in many cases a bodily enfeeblement would be caused which no amount of grammar and geography can compensate for. Nor did it occur to the practical politicians who provided a compulsory load-line for merchant-vessels, that the pressure of ship-owners' interests would habitually cause the putting of the load-line at the very highest limit, and that from precedent to precedent, tending ever in the same direction, the load-line would gradually rise—as from good authority I learn that it has already done. Legislators who, some forty years ago, by act of Parliament compelled railway companies to supply cheap locomotion, would have ridiculed the belief, had it been expressed, that eventually their act would punish the companies which improved the supply; and yet this was the result to companies which began to carry third-class passengers by fast trains, since a penalty to the amount of the passenger-duty was inflicted on them for every third-class passenger so carried. To which instance concerning railways, add a far more striking one disclosed by comparing the railway policies of England and France. The law-makers who provided for the ultimate lapsing of French railways to the state never conceived the possibility that inferior traveling facilities would result—did not foresee that reluctance to depreciate the value of property eventually coming to the state would negative the authorization of competing lines, and that in the absence of competing lines locomotion would be relatively costly, slow, and infrequent; for, as Sir Thomas Farrar has shown, the traveler in England has great advantages over the French traveler in the economy, swiftness, and frequency with which his journeys can be made.

But the "practical" politician, who, in spite of such experiences repeated generation after generation, goes on thinking only of proximate results, naturally never thinks of results still more remote, still more general, and still more important than those just exemplified. To repeat the metaphor used above—he never asks whether the political momentum set up by his measure, in some cases decreasing but in other cases greatly increasing, will or will not have the same general direction with other such momenta; and whether it may not join them in presently producing an aggregate energy working changes never thought of. Dwelling only on the effects of his particular stream of legislation, and not observing how other such streams already existing, and still other streams which will follow his initiative, pursue the same average course, it never occurs to him that they may presently unite

into a voluminous flood utterly changing the face of things. Or to leave figures for a more literal statement, he is unconscious of the truth that he is helping to form a certain type of social organization, and that kindred measures, effecting kindred changes of organization, tend with ever-increasing force to make that type general, until, passing a certain point, the proclivity toward it becomes irresistible. Just as each society aims when possible to produce in other societies a structure akin to its own—just as, among the Greeks, the Spartans and the Athenians severally struggled to spread their respective political institutions, or as, at the time of the French Revolution, the European monarchies aimed to re-establish monarchy in France, so, within every society, each species of structure tends to propagate itself. Just as the system of voluntary co-operation by companies, associations, unions, to achieve business ends and other ends, spreads throughout a community, so does the antagonistic system of compulsory co-operation under state-agencies spread, and the larger becomes its extension the more power of spreading it gets. The question of questions for the politician should ever be, "What type of social structure am I tending to produce?" But this is a question he scarcely ever entertains.

Here we will entertain it for him. Let us now observe the general course of recent changes, with the accompanying current of ideas, and see whither they are carrying us.

The blank form of a question daily asked is, "We have already done this; why should we not do that?" And the regard for precedent suggested by it is ever pushing on regulative legislation. Having had brought within their sphere of operation more and more numerous businesses, the acts restricting hours of employment and dictating the treatment of workers are now to be made applicable to shops. From inspecting lodging-houses to limit the numbers of occupants and enforce sanitary conditions, we have passed to inspecting all houses below a certain rent in which there are members of more than one family, and are now passing to a kindred inspection of all small houses.* The buying and working of telegraphs by the state is made a reason for urging that the state should buy and work the railways. Supplying children with food for their minds by public agency is being followed in some cases by supplying food for their bodies; and, after the practice has been made gradually more general, we may anticipate that the supply now proposed to be made gratis in the one case will eventually be proposed to be made gratis in the other, the argument that good bodies as well as good minds are needful to make good citizens being logically urged as a reason for the extension. And then, avowedly proceeding on the precedents furnished by the church, the school, and the reading-room, all publicly provided, it is contended

* See letter of Local Government Board, "Times," January 2, 1884.

that "pleasure, in the sense it is now generally admitted, needs legislating for and organizing at least as much as work."*

Not precedent only prompts this spread, but also the necessity which arises for supplementing ineffective measures, and for dealing with the artificial evils continually caused. Failure does not destroy faith in the agencies employed, but merely suggests more stringent use of such agencies or wider ramifications of them. Laws to check intemperance, beginning in early times and coming down to our own times, when further restraints on the sale of intoxicating liquors occupy nights every session, not having done what was expected, there come demands for more thorough-going laws, locally preventing the sale altogether; and here, as in America, these will doubtless be followed by demands that prevention shall be made universal. All the many appliances for "stamping out" epidemic diseases not having succeeded in preventing outbreaks of small-pox, fevers, and the like, a further remedy is applied for in the shape of police-power to search houses for diseased persons, and authority for medical officers to examine any one they think fit, to see whether he or she is suffering from an infectious or contagious malady. Habits of improvidence having for generations been cultivated by the poor-law, and the improvident enabled to multiply, the evils produced by compulsory charity are now proposed to be met by compulsory insurance.

The extension of this policy, causing extension of corresponding ideas, fosters everywhere the tacit assumption that Government should step in whenever anything is not going right. "Surely you would not have this misery continue!" exclaims some one, if you hint a demurrer to much that is now being said and done. Observe what is implied by this exclamation. It takes for granted, first, that all suffering ought to be prevented, which is not true: much suffering is curative, and prevention of it is prevention of a remedy. In the second place, it takes for granted that every evil can be removed: the truth being that, with the existing defects of human nature, many evils can only be thrust out of one place or form into another place or form—often being increased by the change. The exclamation also implies the unhesitating belief, here especially concerning us, that evils of all kinds should be dealt with by the state. There does not occur the inquiry whether there are at work other agencies capable of dealing with evils, and whether the evils in question may not be among those which are best dealt with by these other agencies. And obviously, the more numerous governmental interventions become, the more confirmed does this habit of thought grow, and the more loud and perpetual the demands for intervention.

Every extension of the regulative policy involves an addition to the regulative agents—a further growth of officialism and an increas-

* "Fortnightly Review," January, 1884, p. 21.

ing power of the organization formed of officials. Take a pair of scales with many shot in the one and a few in the other. Lift shot after shot out of the loaded scale and put it into the unloaded scale. Presently you will produce a balance, and, if you go on, the position of the scales will be reversed. Suppose the beam to be unequally divided, and let the lightly loaded scale be at the end of a very long arm; then the transfer of each shot, producing a much greater effect, will far sooner bring about a change of position. I use the figure to illustrate what results from transferring one individual after another from the regulated mass of the community to the regulating structures. The transfer weakens the one and strengthens the other in a far greater degree than is implied by the relative change of numbers. A comparatively small body of officials, coherent, having common interests, and acting under central authority, has an immense advantage over an incoherent public which has no settled policy, and can be brought to act unitedly only under strong provocation. Hence an organization of officials, once passing a certain stage of growth, becomes less and less resistible; as we see in the bureaucracies of the Continent.

Not only does the power of resistance of the regulated part decrease in a geometrical ratio as the regulating part increases, but the private interests of many in the regulated part itself make the change of ratio still more rapid. In every circle conversations show that now, when the passing of competitive examinations renders them eligible for the public service, youths are being educated in such ways that they may pass them and get employment under Government. One consequence is, that men who might otherwise reprobate some further growth of officialism are led to look on it with tolerance, if not favorably, as offering possible careers for those dependent on them and those related to them. Any one who remembers the numbers of upper-class and middle-class families anxious to place their children will see that no small encouragement to the spread of legislative control is now coming from those who, but for the personal interests thus arising, would be hostile to it.

This pressing desire for careers is enforced by the preference for careers which are thought respectable. "Even if his salary is small, his occupation will be that of a gentleman," thinks the father, who wants to get a Government-clerkship for his son. And this relative dignity of state-servants, as compared with those occupied in business, increases as the administrative organization becomes a larger and more powerful element in society, and tends more and more to fix the standard of honor. The prevalent ambition with a young Frenchman is to get some small official post in his locality, to rise thence to a place in the local center of government, and finally to reach some head office in Paris. And in Russia, where that universality of state-regulation which characterizes the militant type of society has been carried farthest, we see this ambition pushed to its extreme. Says Mr. Wallace,

quoting a passage from a play, "All men, even shopkeepers and cobblers, aim at becoming officers, and the man who has passed his whole life without official rank seems to be not a human being."*

These various influences, working from above downward, meet with an increasing response of expectations and solicitations proceeding from below upward. The hard-worked and overburdened who form the great majority, and still more the incapables perpetually helped, who are ever led to look for more help, are ready supporters of schemes which promise them this or the other benefit by state agency, and ready believers of those who tell them that such benefits can be given and ought to be given. They listen with eager faith to all builders of political air-castles, from Oxford graduates down to Irish irreconcilables, and every additional tax-supported appliance for their welfare raises hopes of further ones. Indeed, the more numerous public instrumentalities become, the more is there generated in citizens the notion that everything is to be done for them, and nothing by them. Each generation is made less familiar with the attainment of desired ends by individual actions or private combinations, and more familiar with the attainment of them by governmental agencies; until, eventually, governmental agencies come to be thought of as the only available agencies. This result was well shown in the recent Trades-Unions Congress at Paris. The English delegates, reporting to their constituents, said that, between themselves and their foreign colleagues, "the point of difference was the extent to which the state should be asked to protect labor": reference being thus made to the fact, conspicuous in the reports of the proceedings, that the French delegates always invoked governmental power as the only means of satisfying their wishes.

The diffusion of education has worked, and will work still more, in the same direction. "We must educate our masters," is the well-known saying of a Liberal who opposed the last extension of the franchise. Yes, if the education were worthy to be so called, and were relevant to the political enlightenment needed, much might be hoped from it. But knowing rules of syntax, being able to add up correctly, having geographical information, and a memory stocked with the dates of kings' accessions and generals' victories, no more imply fitness to form political conclusions than acquirement of skill in drawing implies expertness in telegraphing, or than ability to play cricket implies proficiency on the violin. "Surely," rejoins some one, "facility in reading opens the way to political knowledge." Doubtless; but will the way be followed? Table-talk proves that nine out of ten people read what amuses them or interests them rather than what instructs them, and that the last thing they read is something which tells them disagreeable truths or dispels groundless hopes. That popular education

* "Russia," i, 422.

results in an extensive reading of publications which foster pleasant illusions, rather than of those which insist on hard realities, is beyond question. Says "A Mechanic," writing in the "Pall Mall Gazette" of December 3, 1883:

> Improved education instills the desire for culture—culture instills the desire for many things as yet quite beyond workingmen's reach; . . . in the furious competition to which the present age is given up they are utterly impossible to the poorer classes; hence they are discontented with things as they are, and the more educated the more discontented. Hence, too, Mr. Ruskin and Mr. Morris are regarded as true prophets by many of us.

And, that the connection of cause and effect here alleged is a real one, we may see clearly enough in the present state of Germany.

Being possessed of electoral power, as are now the mass of those who are thus led to nurture sanguine anticipations of benefits to be obtained by social reorganization, it results that whoever seeks their votes must at least refrain from exposing their mistaken beliefs, even if he does not yield to the temptation to express agreement with them. Every candidate for Parliament is prompted to propose or support some new piece of *ad captandum* legislation. Nay, even the chiefs of parties, these anxious to retain office and those to wrest it from them, severally aim to get adherents by outbidding one another. Each endeavors to score a trick by trumping his antagonist's good card, as we have lately seen. And then, as divisions in Parliament show us, the traditional loyalty to leaders overrides questions concerning the intrinsic propriety of proposed measures. Representatives are unconscientious enough to vote for bills which they regard as essentially wrong in principle, because party-needs and regard for the next election demand it. And thus a vicious policy is strengthened even by those who see its viciousness.

Meanwhile there goes on out-of-doors an active propaganda to which all these influences are ancillary. Communistic theories, partially indorsed by one act of Parliament after another, and tacitly if not avowedly favored by numerous public men seeking supporters, are being advocated more and more vociferously under one or other form by popular leaders, and urged on by organized societies. There is the movement for land-nationalization which, aiming at a system of land-tenure equitable in the abstract, is, as all the world knows, pressed by Mr. George and his friends with avowed disregard for the just claims of existing owners, and as the basis of a scheme going more than half-way to state-communism. And then there is the thorough-going Democratic Federation of Mr. Hyndman and his adherents. We are told by them that "the handful of marauders who now hold possession [of the land] have and can have no right save brute force against the tens of millions whom they wrong." They exclaim against "the shareholders who have been allowed to lay hands upon (!) our great

railway communications." They condemn "above all, the active capitalist class, the loan-mongers, the farmers, the mine-exploiters, the contractors, the middlemen, the factory-lords—these, the modern slave-drivers" who exact "more and yet more surplus value out of the wage-slaves whom they employ." And they think it "high time" that trade should be "removed from the control of individual greed and individual profit."*

It remains to point out that the tendencies thus variously displayed are being strengthened by press-advocacy, daily more pronounced. Journalists, always chary of saying that which is distasteful to their readers, are some of them going with the stream and adding to its force. Legislative meddlings which they would once have condemned they now pass in silence, if they do not advocate them; and they speak of *laisser-faire* as an exploded doctrine. "People are no longer frightened at the thought of socialism," is the statement which meets us one day. On another day, a town which does not adopt the Free Libraries Act is sneered at as being alarmed by a measure so moderately communistic. And then, along with editorial assertions that this economic evolution is coming and must be accepted, there is prominence given to the contributions of its advocates. Meanwhile those who regard the recent course of legislation as disastrous, and see that its future course is likely to be still more disastrous, are being reduced to silence by the belief that it is useless to reason with people in a state of political intoxication.

See, then, the many concurrent causes which threaten continually to accelerate the transformation now going on. There is that spread of regulation caused by following precedents, which become the more authoritative the further the policy is carried. There is that increasing need for administrative compulsions and restraints which results from the unforeseen evils and short-comings of preceding compulsions and restraints. Moreover, every additional state-interference strengthens the tacit assumption that it is the duty of the state to deal with all evils and secure all benefits. Increasing power of a growing administrative organization is accompanied by decreasing power of the rest of the society to resist its further growth and control. The multiplication of careers opened by a developing bureaucracy tempts members of the classes regulated by it to favor its extension, as adding to the chances of safe and respectable places for their relatives. The people at large, led to look on benefits received through public agencies as gratis benefits, have their hopes continually excited by the prospects of more. A spreading education, furthering the diffusion of pleasing errors rather than of stern truths, renders such hopes both stronger and more general. Worse still, such hopes are ministered to by candidates for public choice to augment their chances of success;

* "Socialism made Plain," Reeves, 185 Fleet Street.

and leading statesmen, in pursuit of party ends, bid for popular favor by countenancing them. Getting repeated justifications from new laws harmonizing with their doctrines, political enthusiasts and unwise philanthropists push their agitations with growing confidence and success. Journalism, ever responsive to popular opinion, daily strengthens it by giving it voice; while counter-opinion, more and more discouraged, finds little utterance.

Thus influences of various kinds conspire to increase corporate action and decrease individual action. And the change is being on all sides aided by schemers, each of whom thinks only of his pet project, and not at all of the general reorganization which his, joined with others such, are working out. It is said that the French Revolution devoured its own children. Here an analogous catastrophe seems not unlikely. The numerous socialistic changes made by act of Parliament, joined with the numerous others presently to be made, will by-and-by be all merged in state-socialism—swallowed in the vast wave which they have little by little raised.

"But why is this change described as 'the coming slavery'?" is a question which many will still ask. The reply is simple. All socialism involves slavery.

What is essential to the idea of a slave? We primarily think of him as one who is owned by another. To be more than nominal, however, the ownership must be shown by control of the slave's actions—a control which is habitually for the benefit of the controller. That which fundamentally distinguishes the slave is that he labors under coercion to satisfy another's desires. The relation admits of sundry gradations. Remembering that originally the slave is a prisoner whose life is at the mercy of his captor, it suffices here to note that there is a harsh form of slavery in which, treated as an animal, he has to expend his entire effort for his owner's advantage. Under a system less harsh, though occupied chiefly in working for his owner, he is allowed a short time in which to work for himself, and some ground on which to grow extra food. A further amelioration gives him power to sell the produce of his plot and keep the proceeds. Then we come to the still more moderated form which commonly arises where, having been a free man working on his own land, conquest turns him into what we distinguish as a serf; and he has to give to his owner each year a fixed amount of labor or produce, or both, retaining the rest himself. Finally, in some cases, as in Russia until recently, he is allowed to leave his owner's estate and work or trade for himself elsewhere, under the condition that he shall pay an annual sum. What is it which, in these cases, leads us to qualify our conception of the slavery as more or less severe? Evidently the greater or smaller extent to which effort is compulsorily expended for the benefit of another instead of for self-benefit. If all the slave's labor is for his

owner the slavery is heavy, and if but little it is light. Take now a further step. Suppose an owner dies, and his estate with its slaves comes into the hands of trustees, or suppose the estate and everything on it to be bought by a company; is the condition of the slave any the better if the amount of his compulsory labor remains the same? Suppose that for a company we substitute the community; does it make any difference to the slave if the time he has to work for others is as great, and the time left for himself is as small, as before? The essential question is, How much is he compelled to labor for other benefit than his own, and how much he can labor for his own benefit? The degree of his slavery varies according to the ratio between that which he is forced to yield up and that which he is allowed to retain; and it matters not whether his master is a single person or a society. If, without option, he has to labor for the society, and receives from the general stock such portion as the society awards him, he becomes a slave to the society. Socialistic arrangements necessitate an enslavement of this kind; and toward such an enslavement many recent measures, and still more the measures advocated, are carrying us. Let us observe, first, their proximate effects, and then their ultimate effects.

The policy initiated by the Industrial Dwellings Acts admits of development, and will develop. Where municipal bodies turn house-builders, they inevitably lower the values of houses otherwise built, and check the supply of more. Every dictation respecting modes of building and conveniences to be provided diminishes the builder's profit, and prompts him to use his capital where the profit is not thus diminished. So, too, the owner, already finding that small houses entail much labor and many losses—already subject to troubles of inspection and interference and to consequent costs, and having his property daily rendered a more undesirable investment—is prompted to sell; and, as buyers are for like reasons deterred, he has to sell at a loss. And now these still multiplying regulations, ending, it may be, as Lord Grey proposes, in one requiring the owner to maintain the salubrity of his houses by evicting dirty tenants, and thus adding to his other responsibilities that of inspector of nuisances, must further prompt sales and further deter purchasers—so necessitating greater depreciation. What must happen? The multiplication of houses, and especially small houses, being increasingly checked, there must come an increasing demand upon the local authority to make up for the deficient supply. More and more, the municipal or kindred body will have to build houses, or to purchase houses rendered unsalable to private persons in the way shown; houses which, greatly depreciated in value as they must become, it will, in many cases, pay to buy rather than to build new ones. And then, when in towns this process has gone so far as to make the local authority the chief owner of houses, there will be a good precedent for publicly providing houses for the

rural population, as proposed in the Radical programme,* and as urged by the Democratic Federation, which insists on "the compulsory construction of healthy artisans' and agricultural laborers' dwellings in proportion to the population." Manifestly, the tendency of that which has been done, is being done, and is presently to be done, is to approach the socialistic ideal in which the community is sole house-proprietor.

Such, too, must be the effect of the daily growing policy on the tenure and utilization of the land. More numerous public benefits, to be achieved by more numerous public agencies, at the cost of augmented public burdens, must increasingly deduct from the returns on land; until, as the depreciation in value becomes greater and greater, the resistance to change of tenure becomes less and less. Already, as every one knows, there is in many places difficulty in obtaining tenants, even at greatly reduced rents; and land of inferior fertility in some cases lies idle, or when farmed by the owner is often farmed at a loss. Clearly the margin of profit on capital invested in land is not such that taxes, local and general, can be greatly raised to support extended public administrations, without an absorption of it which will prompt owners to sell, and make the best of what reduced price they can get by emigrating and buying land not subject to heavy burdens, as, indeed, some are now doing. This process, carried far, must have the result of throwing inferior land out of cultivation; after which there will be raised more generally the demand made by Mr. Arch, who, addressing the Radical Association of Brighton lately, and contending that existing landlords do not make their land adequately productive for the public benefit, said "he should like the present Government to pass a Compulsory Cultivation Bill": an applauded proposal which he justified by instancing compulsory vaccination (thus illustrating the influence of precedent). And this demand will be pressed, not only by the need for making the land productive, but also by the need for employing the rural population. After the Government has extended the practice of hiring the unemployed to work on deserted lands, or lands acquired at nominal prices, there will be reached a stage whence there is but a small further step to that arrangement which, in the programme of the Democratic Federation, is to follow nationalization of the land—the "organization of agricultural and industrial armies under state control on co-operative principles."

If any one doubts that such a revolution may be so reached, facts may be cited to show its likelihood. In Gaul, during the decline of the Roman Empire, "so numerous were the receivers in comparison with the payers, and so enormous the weight of taxation, that the laborer broke down, the plains became deserts, and woods grew where

* "Fortnightly Review," November, 1883, pp. 619, 620.

the plow had been."* In like manner, when the French Revolution was approaching, the public burdens had become such that many farms remained uncultivated, and many were deserted: one quarter of the soil was absolutely lying waste; and in some provinces one half was in heath.† Nor have we been without incidents of a kindred nature at home. Besides the facts that under the old poor-law the rates had in some parishes risen to half the rental, and that in various places farms were lying uncultivated, there is the fact that in one case the rates had absorbed the whole proceeds of the soil.

At Cholesbury, in Buckinghamshire, in 1832, the poor-rate "suddenly ceased in consequence of the impossibility to continue its collection, the landlords having given up their rents, the farmers their tenancies, and the clergyman his glebe and his tithes. The clergyman, Mr. Jeston, states that in October, 1832, the parish officers threw up their books, and the poor assembled in a body before his door while he was in bed, asking for advice and food. Partly from his own small means, partly from the charity of neighbors, and partly by rates in aid, imposed on the neighboring parishes, they were for some time supported."‡

The commissioners add that "the benevolent rector recommends that the whole of the land should be divided among the able-bodied paupers": hoping that, after help afforded for two years, they might be able to maintain themselves. These facts, giving color to the prophecy made in Parliament that continuance of the old poor-law for another thirty years would throw the land out of cultivation, clearly prove that increase of public burdens may end in forced cultivation under public control.

Then, again, comes state-ownership of railways. Already this exists to a large extent on the Continent. Already we have had here a few years ago loud advocacy of it. And now the cry which was raised by sundry politicians and publicists is taken up afresh by the Democratic Federation, which proposes "state-appropriation of railways, with or without compensation." Evidently, pressure from above joined by pressure from below is likely to effect this change, dictated by the policy everywhere spreading; and with it must come many attendant changes. For railway-proprietors, at first owners and workers of railways only, have been allowed to become masters of numerous businesses directly or indirectly connected with railways; and these will have to be purchased by Government when the railways are purchased. Already exclusive carrier of letters, exclusive transmitter of telegrams, and on the way to become exclusive carrier of parcels, the state will not only be exclusive carrier of passengers, goods, and minerals, but will add to its present various trades many

* Lactant., "De M. Persecut.," cc. 7, 23.

† Taine, "La Révolution," pp. 337, 338.

‡ "Report of Commissioners for Inquiry into the Administration and Practical Operation of the Poor-Laws," p. 37, February 20, 1834.

other trades. Even now, besides erecting its naval and military establishments, and building harbors, docks, breakwaters, etc., it does the work of ship-builder, cannon-founder, small-arms maker, manufacturer of ammunition, etc., etc.; and, when the railways have been appropriated "with or without compensation," as the Democratic Federationists say, it will have to become locomotive-engine builder, carriage-maker, tarpaulin and grease manufacturer, passenger-vessel owner, coal-miner, stone-quarrier, omnibus-proprietor, etc. Meanwhile its local lieutenants, the municipal governments, already in many places suppliers of water, gas-makers, owners and workers of tramways, proprietors of baths, will doubtless have undertaken various other businesses. And when the state, directly or by proxy, has thus come into possession of, or has established, numerous concerns for wholesale production and for wholesale distribution, there will be good precedents for extending its function to retail distribution: following such an example, say, as is offered by the French Government, which has long been a retail tobacconist.

Evidently, then, the changes made, the changes in progress, and the changes urged, are carrying us not only toward state-ownership of land and dwellings and means of communication, all to be administered and worked by state-agents, but toward state-usurpation of all industries; the private forms of which, disadvantaged more and more in competition with the state, which can arrange everything for its own convenience, will more and more die away just as many voluntary schools have, in presence of board-schools. And so will be brought about the desired ideal of the socialist.

And now when there has been reached this desired ideal, which "practical" politicians are helping socialists to reach, and which is so tempting on that bright side which socialists contemplate, what must be the accompanying shady side which they do not contemplate? It is a matter of common remark, often made when a marriage is impending, that those possessed by strong hopes habitually dwell on the promised pleasures and think nothing of the accompanying pains. A further exemplification of this truth is supplied by these political enthusiasts and fanatical revolutionists. Impressed with the miseries existing under our present social arrangements, and not regarding these miseries as caused by the ill-working of a human nature but partially adapted to the social state, they imagine them to be forthwith curable by this or that rearrangement. Yet, even did their plans succeed, it could only be by substituting one kind of evil for another. A little deliberate thought would show that under their proposed arrangements their liberties must be surrendered in proportion as their material welfares were cared for.

For no form of co-operation, small or great, can be carried on without regulation and an implied submission to the regulating

agencies. Even one of their own organizations for effecting social changes yields them proof. It is compelled to have its councils, its local and general officers, its authoritative leaders, who must be obeyed under penalty of confusion and failure. And the experience of those who are loudest in their advocacy of a new social order under the paternal control of a government shows that, even in private voluntarily-formed societies, the power of the regulative organization becomes great, if not irresistible; often, indeed, causing grumbling and restiveness among those controlled. Trades-unions which carry on a kind of industrial war in defense of workers' interests *versus* employers' interests find that subordination almost military in its strictness is needful to secure efficient action; for divided councils prove fatal to success. And even in bodies of co-operators, formed for carrying on manufacturing or distributing businesses, and not needing that obedience to leaders which is required where the aims are offensive or defensive, it is still found that the administrative agency acquires so great a power that there arise complaints about "the tyranny of organization." Judge, then, what must happen when, instead of combinations, small, local, and voluntary, to which men may belong or not as they please, we have a national combination in which each citizen finds himself incorporated, and from which he can not separate himself without leaving the country! Judge what must under such conditions become the power of a graduated and centralized officialism, holding in its hands the resources of the community, and having behind it whatever amount of force it finds requisite to carry out its decrees and maintain what it calls order! Well may a Prince Bismarck display leanings toward state-socialism.

And then, after recognizing, as they must if they think out their scheme, the power possessed by the regulative agency in the new social system so temptingly pictured, let its advocates ask themselves to what end this power must be used. Not dwelling exclusively, as they habitually do, on the material well-being and the mental gratifications to be provided for them by a beneficent administration, let them dwell a little on the price to be paid. The officials can not create the needful supplies; they can but distribute among individuals that which the individuals have joined to produce. If the public agency is required to provide for them, it must reciprocally require them to furnish the means. There can not be, as under our existing system, agreement between employer and employed—this the scheme excludes. There must in place of it be command by local authorities over workers, and acceptance by the workers of that which the authorities assign to them. And this, indeed, is the arrangement distinctly, but as it would seem inadvertently, pointed to by the members of the Democratic Federation. For they propose that production should be carried on by "agricultural and industrial *armies* under state control"; apparently not remembering that armies presuppose

grades of officers, by whom obedience would have to be insisted upon, since otherwise neither order nor efficient work could be insured. So that each would stand toward the governing agency in the relation of slave to master.

"But the governing agency would be a master which he and others made and kept constantly in check, and one which therefore would not control him or others more than was needful for the benefit of each and all."

To which reply the first rejoinder is that, even if so, each member of the community as an individual would be a slave to the community as a whole. Such a relation has habitually existed in militant communities, even under *quasi*-popular forms of government. In ancient Greece the accepted principle was that the citizen belonged neither to himself nor to his family, but belonged to his city—the city being with the Greek equivalent to the community. And this doctrine, proper to a state of constant warfare, is a doctrine which socialism unawares reintroduces into a state intended to be purely industrial. The services of each will belong to the aggregate of all; and for these services such returns will be given as the authorities think proper. So that even if the administration is of the beneficent kind intended to be secured, slavery, however mild, must be the outcome of the arrangement.

A second rejoinder is that the administration will presently become not of the intended kind, and that the slavery will not be mild. The socialist speculation is vitiated by an assumption like that which vitiates the speculations of the "practical" politician. It is assumed that officialism will work as it is intended to work, which it never does. The machinery of communism, like existing social machinery, has to be framed out of existing human nature; and the defects of existing human nature will generate in the one the same evils as in the other. The love of power, the selfishness, the injustice, the untruthfulness, which often in comparatively short times bring private organizations to disaster, will inevitably, where their effects accumulated from generation to generation, work evils far greater and less remediable; since vast and complex and possessed of all the resources, the administrative organization once developed and consolidated must become irresistible. And, if there needs proof that the periodic exercise of electoral power would fail to prevent this, it suffices to instance the French Government, which, purely popular in origin, and subject from time to time to popular judgment, nevertheless tramples on the freedom of citizens to an extent which the English delegates to the late Trades-Union Congress say "is a disgrace to, and an anomaly in, a republican nation."

The final result would be a revival of despotism. A disciplined army of civil officials, like an army of military officials, gives supreme power to its head—a power which has often led to usurpation, as in

mediæval Europe and still more in Japan—nay, has thus so led among our neighbors within our own times. The recent confessions of M. de Maupas have shown how readily a constitutional head, elected and trusted by the whole people, may, with the aid of a few unscrupulous confederates, paralyze the representative body and make himself autocrat. That those who rose to power in a socialistic organization would not scruple to carry out their aims at all costs, we have good reason for concluding. When we find that shareholders, who, sometimes gaining, but often losing, have made that railway-system by which national prosperity has been so greatly increased, are spoken of by the council of the Democratic Federation as having "laid hands" on the means of communication, we may infer that those who directed a socialistic administration might interpret with extreme perversity the claims of individuals and classes under their control. And when, further, we find members of this same council urging that the state should take possession of the railways, "with or without compensation," we may suspect that the heads of the ideal society desired, would be but little deterred by considerations of equity from pursuing whatever policy they thought needful—a policy which would always be one identified with their own supremacy. It would need but a war with an adjacent society, or some internal discontent demanding forcible suppression, to at once transform a socialistic administration into a grinding tyranny like that of ancient Peru; under which the mass of the people, controlled by grades of officials, and leading lives that were inspected out-of-doors and in-doors, labored for the support of the organization which regulated them, and were left with but a bare subsistence for themselves. And then would be completely revived, under a different form, that *régime* of status—that system of compulsory co-operation, the decaying tradition of which is represented by the old Toryism, and toward which the new Toryism is carrying us back.

"But we shall be on our guard against all that—we shall take precautions to ward off such disasters," will doubtless say the enthusiasts. Be they "practical" politicians with their new regulative measures, or communists with their schemes for reorganizing labor, the answer is ever the same: "It is true that plans of kindred nature have, from unforeseen causes and adverse accidents, or the misdeeds of those concerned, been brought to failure; but this time we shall profit by past experiences and succeed." There seems no getting people to accept the truth, which nevertheless is conspicuous enough, that the welfare of a society and the justice of its arrangements are at bottom dependent on the characters of its members; and that improvement in neither can take place without that improvement in character which results from carrying on peaceful industry under the restraints imposed by an orderly social life. The belief, not only of the socialists but also of those so-called Liberals who are diligently preparing the way

for them, is that by due skill an ill-working humanity may be framed into well-working institutions. It is a delusion. The defective natures of citizens will show themselves in the bad acting of whatever social structure they are arranged into. There is no political alchemy by which you can get golden conduct out of leaden instincts.

THE ELECTRIC RAILWAY.

By Lieutenant BRADLEY A. FISKE, U. S. N.

WITH most men who have not had time to follow the progress made of late in applying electricity to the practical work of the world, this form of energy is chiefly associated with certain experiments at school, by which the tedium of book-studying was enlivened with exhibitions of sparks and shocks and other curious and interesting phenomena, though it may be also connected in their minds with electric hair-brushes, electric corsets, magnetic clothing, etc. They regard it also as convenient for sending dispatches by telegraph, and in general for doing work where delicacy but not much force is requisite; but the idea seldom occurs to them that this versatile power is capable of swiftly moving the mightiest masses, as well as of operating the tiniest apparatus; of turning the wheels of ponderous machinery, as well as of vibrating thousands of times per second the little diaphragm of the telephone; of conveying to far-distant points the waste power of cataracts, as well as the minute forces liberated by the telegraphic key, and of illuminating, with the purest artificial light known, the most extensive and thickly populated cities.

Doubtless, one great cause of the skepticism with which many regard any project for using electricity upon a large scale is the fact that exhaustive experiments in this direction were made in the early part of the century, and the conclusion reached was that, though power and light could both be distributed by electricity, yet the expense would be so enormous as to render impracticable any extended electrical system.

It should not be forgotten, however, that the only great trouble found was the expense, and also that the principal source of this expense has been removed. In those days, the only way of generating an electric current was by the use of the voltaic battery, in which the electrical energy of the current was procured from the heat of the chemical combination going on in the battery; but in 1831 Faraday discovered a much cheaper way of generating electricity, when he found that it could be produced by simply moving magnets in the

vicinity of coils of wire, or coils of wire in the vicinity of magnets. The significance of his discovery was so apparent that inventors began at once to devise means for generating currents upon an extended scale, by moving large magnets in the vicinity of large coils of wire by means of machinery; and this mechanical system has now been brought to such perfection that the cost of producing a horse-power of electrical energy can be as easily and almost as accurately calculated as the cost of producing a horse-power in a steam-engine or any other familiar apparatus.

In order to arrive at a clear comprehension of the present state of the art, it will be necessary to remember that any work which we perform must be performed by the expenditure of a certain and absolute amount of energy, and that we can not create this energy, but can only obtain it by changing the form of some other kind of energy. In the voltaic battery, as we have said, the electrical energy is obtained by transforming the heat of the chemical action going on in the cell into electrical energy, so that the amount of the latter that can be got out of any voltaic battery is limited by the amount of energy of the chemical combination. Now, the metal ordinarily used for furnishing chemical energy in a voltaic battery is zinc, and the heat of combination of zinc with oxygen is only about one sixth of that of coal, while its cost is more than twenty times as great; so that, to get the same amount of energy from zinc as from coal, would cost about one hundred and twenty times as much. Now, in the mechanical method of generating electricity, the electrical energy is produced by the mechanical means of moving large magnets near coils of wire; but the mechanical energy necessary to do this is obtained by the combustion of coal (i. e., the chemical combination of coal with oxygen).

It would be incorrect, however, to say that we can in this way produce electricity one hundred and twenty times as cheaply as by a battery, because there is an enormous loss in converting the heat of combustion of the coal into electricity, whereas the voltaic battery produces the electricity directly. The losses in converting the energy of the combustion of coal into mechanical energy are so prodigious that even a theoretically perfect engine could not get hold of more than from twenty to twenty-five per cent of the total energy in the coal, on account of the loss of the heat; so that, if an engine (a good one) has an efficiency of eighty per cent, it can not actually convert into work as much as twenty per cent of the total energy in the coal. The loss now in converting this mechanical energy into the electrical energy in the circuit where it is desired may be taken as about fifteen per cent, so that only about from fifteen to seventeen per cent of the total energy of the burning coal may be looked for in the electrical circuit. But, as the original cost of the coal is only $\frac{1}{120}$ of that of the zinc furnishing an equal amount of energy, we see that the mechanical method

of producing electricity is, roughly speaking, about twenty times as cheap as that of generating it by batteries.

The present way of generating large quantities of electricity requires, then, an engine and boiler for converting the chemical energy of burning coal into mechanical energy, and a device whereby this mechanical energy is made to move magnets in the vicinity of coils of wire or coils of wire in the vicinity of magnets, so as to convert the mechanical energy into electrical energy. Such a device is called an electric machine, or, ordinarily, a dynamo-electric machine; and this term is usually abbreviated into "dynamo."

A dynamo of a type in considerable use, and one of the earliest and best forms, is shown in Fig. 1. In this dynamo, coils of wire are wrapped about the long "armature" shown in the center, which is revolved between the poles of the large magnet (A) by a belt coming from a steam-engine, and going around the armature-pulley seen at

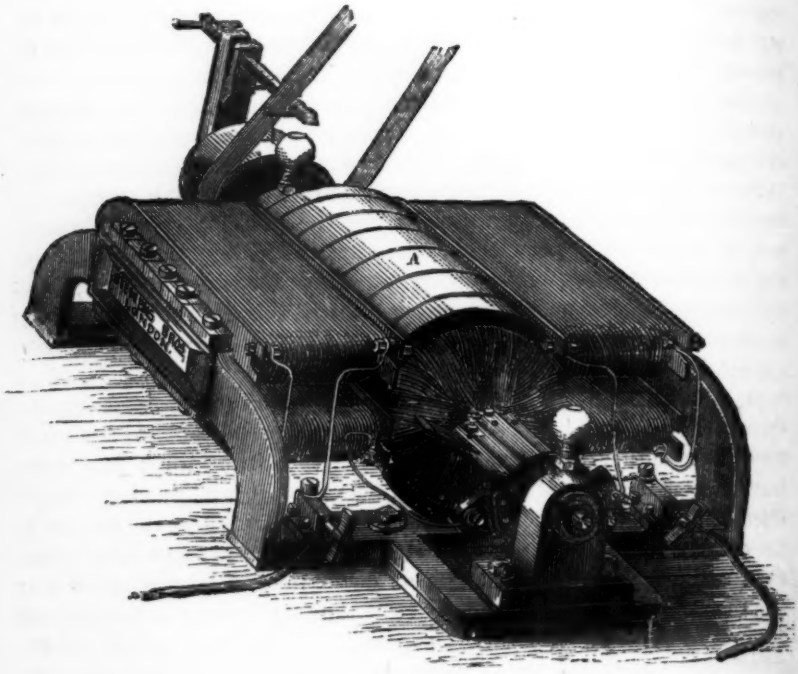

FIG. 1.

the rear. The approach to and recession from the poles of the different coils of wire of the armature generate a succession of currents which are collected by "brushes," and sent out into the circuit as a constant current.

But a most beautiful example of the truth of the theory of the

conservation of energy is afforded by the fact that a dynamo will not only generate an electric current if it be revolved by mechanical means, but that it will itself revolve, if an electric current be sent through it from an exterior source; so that it not only can transform mechanical energy into electrical energy, but can also transform electrical into mechanical energy. When used for this purpose it is called an "electro-motor," and sometimes an "electric engine."

Not only, however, is it necessary for an engine to be capable of doing a certain kind of work; it is also necessary for it to be capable of doing it economically, and it is for this reason that such a great future is prophesied for electric engines. For, while an excellent and elaborately constructed stationary steam-engine can produce but a small fraction of the energy it absorbs, a good electric engine (or electro-motor) will return seventy-five per cent of the electric energy given it by the generating dynamo. For the reason, however, that no economical means of generating large currents are yet discovered, except the method described of first burning coal, the use of electric machinery is at present restricted to certain industries. Now, one of these industries is believed to be railroading.

The opinion is generally held that railroad companies desire to obtain as large a return as possible upon their investment, and therefore to run their trains as cheaply as possible. If this be true, the value of an electric railway will become obvious, when one remembers that, of necessity, the present locomotive is wasteful in the extreme, and that in an electric railway a large and economical stationary engine renders its mechanical energy to a large and economical dynamo which sends an electric current to an economical motor on an electric locomotive. This motor is connected with the driving-wheels by gearing, belting, or other suitable devices, so that its revolution produces a revolution of the driving-wheels and a consequent progressive motion of the electric locomotive, in the same way that the engine of a steam-locomotive produces a rotary motion of the driving-wheels, and a consequent progressive motion of the steam-locomotive. There is a certain loss of electricity in passing from the dynamo to the motor on the locomotive, both from leakage and from overcoming the resistance of the conductors; but, for distances not too great, this loss, added to the losses in converting the mechanical energy of the stationary engine into electrical energy, and in reconverting this electrical energy back into mechanical energy by the motor, is not equal to the loss inseparable from even the best steam-locomotives.

It will be, of course, noticed that it is necessary constantly to maintain an electrical connection between the electro-motor on the locomotive and the stationary dynamo, in all positions of the locomotive. To accomplish this effectively, a number of systems have been invented. By one system the rails themselves act as conductors, the

current going to the locomotive by one rail and returning by the other; while, in other systems, a third or auxiliary conductor is used. To collect the current and pass it through the motor, two strips of copper or brass in the circuit of the motor extend from the locomotive and press upon the conductors; so that, as the car advances, these keep up a scraping contact. Two wheels in circuit with the motor are also sometimes used as collectors.

The distinction of being the first to conceive and suggest the idea of an electric railway seems to belong to Dr. Werner Siemens, of the celebrated firm of Siemens & Halske, which has been more identified with the practical development of electrical science than any other firm in the world. In pursuance of his idea, Dr. Siemens constructed the first electrical railway at Berlin in 1879.

In this railway, whose length was about three hundred and fifty yards, and whose gauge was about three feet and three inches, a third or auxiliary conductor was used to convey the current from the dynamo to the motor. This conductor lay between and parallel to the other two rails, and the current was taken from it by a metal brush connected with the motor, which extended from the car and pressed upon the conductor. After going through the motor, the current went to both rails and by them back to the dynamo, the rails acting as the "return." The motor was placed upon a car, attached to which were three other cars, the first thus acting as the locomotive. Such was the interest excited by this novel system of transportation, and such its success, that it continued in operation for several months, and carried thousands of people, the money received for fares being contributed, it is said, to charitable institutions in the city.

The success of this experimental railway led the Messrs. Siemens to plan another upon a more extended scale; and they applied to the authorities for permission to build an elevated road in Berlin, six miles long, on which single cars, each fitted with an electro-motor, were to be run by means of electricity. Permission to do this was refused, on account of the inconvenience to the inhabitants which would result from the structure; but, ultimately, leave was given the same firm to build a surface electric railway from Lichterfelde, one of the suburbs, to the military academy. This railway is still running, and its operation has throughout, for more than two years, been of the most satisfactory character. No auxiliary conductor is used, the current going from the dynamo along one rail, through one of the wheels, through the motor, through a wheel on the opposite side of the car, and thence to the other rail, which acts as the "return." No trains are made up, but each car is fitted with an electro-motor, which lies beneath the flooring. As the authorities declare these cars to fall under the same heading as tram-cars, the speed at which they may be run is limited by law to twelve miles per hour.

This speed is realized with ease, but a much greater rate could be attained, if it were allowed.

It can hardly be hoped, however, that such a simple system as this could be adopted for running cars in the streets of a city, for other difficulties would be introduced. The fact that the rails in the streets must, of necessity, be close to the surface of the ground, and that they are to be stepped upon by men and horses, shows at once the necessity of having the conductor out of the way, and the danger of having the current traverse the rails. At the Electrical Exposition held at Paris in 1881, Messrs. Siemens & Halske had an electric railway in operation, in which a third or auxiliary conductor was used; but this ran along on posts like a telegraph-wire, the current being conveyed from this conductor to the motor by means of a flexible conductor, which was connected at one end with the motor on the car, and at the other with a contact-carriage, or trolly, which was drawn along the conductor by the car as it advanced.

In mines, in tunnels, and in all places where the smoke of burning coal is objectionable, it would seem that the electric railway possesses unrivaled advantages. As the motor gives off no smoke, makes little noise, occupies but a small space, and does not have to carry its own

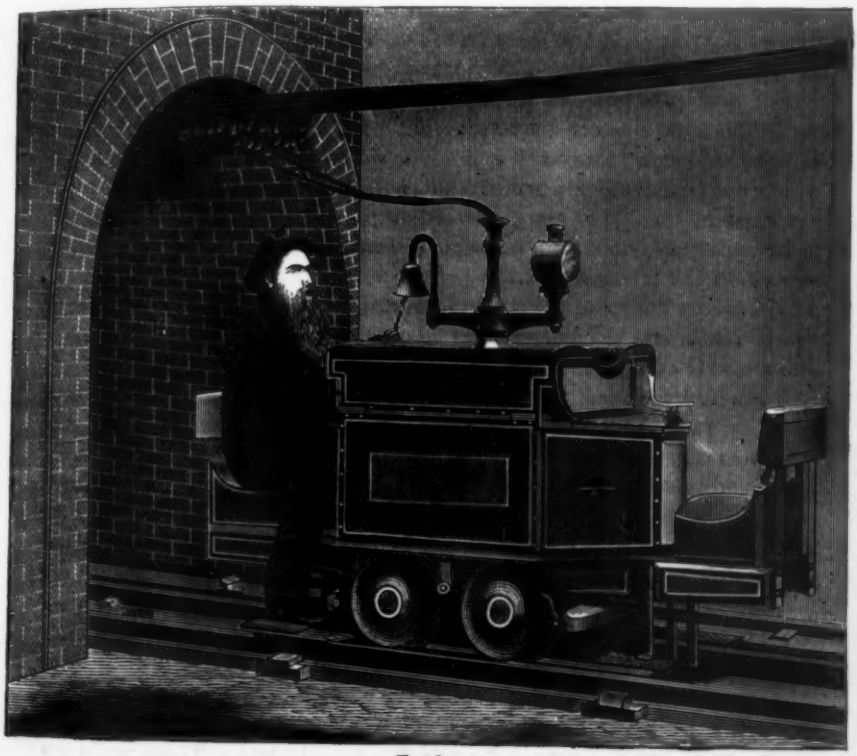

FIG. 2.

fuel, it possesses many points of superiority over the present cumbersome, noisy, smoky locomotive. Indeed, in long passages such as those in the mines at Zankerode, where a Siemens electric railway is now running, a steam-locomotive would be not only undesirable but impossible.

In the Zankerode-mine railway, the current is sent from the dynamo along the roof of the tunnel through one of the inverted T-rails shown in Fig. 2, which thus acts as a conductor, and upon which slides a contact-carriage connected with the motor on the car by one of the flexible conductors, also shown. The return current coming from the motor goes to the other inverted T-iron by the other flexible conductor, and thence back to the dynamo.

The most extensive electric railway now in use is that constructed by Messrs. Siemens in Ireland, which runs from Portrush to Bushmills, a distance of about six miles. As at present operated, a dynamo revolved by a stationary steam-engine supplies the necessary current; but it is intended to utilize the waste power of a waterfall situated about three quarters of a mile from the end of the line, as soon as the necessary works can be constructed. The cost of running the electric locomotives is found to be less than that of running steam-locomotives over the same track, and it will be much reduced as soon as the utilization of the power of the waterfall (twenty-four feet) is made possible.

By another system of electric propulsion, it has been attempted to carry batteries of electric accumulators in the car, instead of conveying the current to the car by conductors. By this system, as yet undeveloped, a large stationary engine is to be used to turn a dynamo which will generate a current that will charge the accumulators or "storage-batteries," as they are sometimes called; these accumulators to lie under the seats or in some other convenient place, and render the current to the motor direct.

As accumulators may play an important part in electric railroading, and as much that is incorrect has appeared in print concerning them, a few words of description may not be out of place.

Probably the most prevalent conception of an accumulator is a box or other receptacle in which electricity is put and from which it can be drawn when desired; and for practical purposes this idea is sufficiently correct. From a scientific point of view, however, it is more satisfactory to regard an accumulator as a battery in which the electrical energy of the current which it renders arises from a chemical action due primarily to another current which was sent through it. To speak more in detail, the ordinary accumulator (Fig. 3) consists of two lead plates standing in acidulated water and capable of behaving like an ordinary voltaic battery, after they have been acted upon by a strong current. This current, called the charging current, when it goes through the liquid, decomposes it, the oxygen, separated, going to one lead plate and the hydrogen to the other lead plate. The oxygen at-

tacks the lead plate to which it goes, thus forming peroxide of lead, and the hydrogen reduces any oxide that may be on the other lead plate, thus producing pure lead, some of the surplus hydrogen forming as a film upon the surface. The charging current is then reversed, so that the latter plate is now attacked, and is then reversed again; the effect of these operations being to render the surfaces of both lead plates porous so that they present a large surface, and can therefore hold a great deal of peroxide of lead. When the charging current is broken, the oxygen, which has been forcibly separated from the liquid, seeks to recombine in the same way that a stone which has been forcibly separated from the earth seeks the earth when liberated. If now the two lead plates be joined with a wire, the effect of the oxygen in the peroxide of lead trying to recombine is to generate an electrical current in the opposite direction to the original one; and this is the current which is utilized. The value of accumulators would be much increased if this return current could be made greater, and if the weight and cost of the accumulators themselves could be made less. At present, however, their use is restricted by reason of their great cost and weight, and by the small ratio (about fifty per cent in practice) of the electrical energy returned to that expended in charging them. Nevertheless, the fact that the accumulator system of electric railroading obviates the necessity for any conductors, which sometimes are inconvenient and expensive, and which themselves occasion great loss of electrical energy, leads many to believe that for short routes, as upon street-car lines of cities, accumulators will be very efficient.

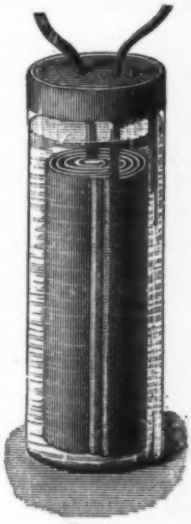

FIG. 3.

At the Chicago Exposition of Railway Appliances, which has just closed, the system of Messrs. T. A. Edison and S. D. Field, of New York, was tried, and with undeniable success. By this system a third conductor is used; but it is not placed upon poles, as in the Siemens system (for this would not be practicable in the streets of a city), but lies in a long sunken trough which runs between and parallel to the rails. The trough is covered, and a long and very narrow slit runs the whole length of the cover. Through this slit extends a strong metallic rod which is connected mechanically with a contact-carriage lying upon the conductor, and which is mechanically and electrically connected with the car.

It is claimed that by means of a scraper, carried by the contact-carriage, there will be no trouble occasioned by any accumulation on the conductor of ice, snow, or mud, but that the car can be satisfactorily run in all kinds of weather.

Fig. 4 represents the generator and track as arranged at the Chi-

SMITHSONIAN INSTITUTE ASSOCIATION 1884

cago Exposition. It will be noticed that one pole of the generator (dynamo) is connected with the auxiliary middle rail, and the other with one of the two side-rails which are metallically connected together, as shown. The current goes to the motor on the car by the middle conductor, and is returned to the generator by the side-rails.

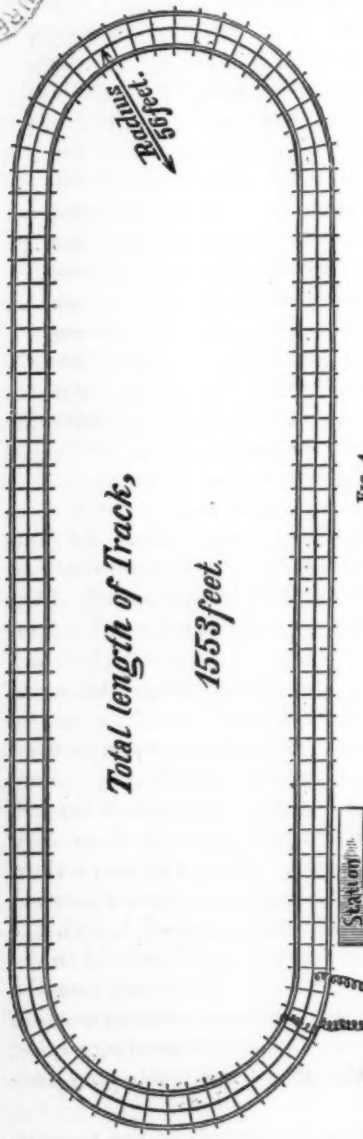

FIG. 4.

The advantages of the electric railway, should it be made practicable in all respects, are obvious, and there is good reason for believing that in time it will be made available and economical even for lines of considerable length.

In the streets of a city, electric cars would be advantageous upon the surface roads for the reason that they could be run more quietly and swiftly than horse-cars, and, as an electric car can be stopped in less than its own length, just as safely; in crowded parts of the city, they could thread their way more rapidly through the crowds of carts and other vehicles, because they can be stopped and started more quickly and require less room. But it would be upon elevated roads that their advantages would be pronounced, for we should then escape much of the noise and all of the smoke and smell that now attend the passing of elevated trains.

By reason of our ability to make every electrical car its own locomotive, it is clear that we can secure greater safety in traveling, and greater frequency in the times of arrival and departure, so that to reach the depot half a minute too late would not be so serious a thing as it now is. As each car is very light, it can be stopped in a much shorter distance than is now possible with a heavy train; and, even if a collision should occur, it would not

be such a horrible thing as a collision between two ponderous trains, not only because of the lightness of the electric cars, but also because they do not carry steam and fire as locomotives do. Another advantage of the lightness of the cars lies in the fact that they will exert less "wear and tear" upon the tracks, and therefore occasion less outlay for repairs.

When the present mode of traveling in Pullman cars is compared with the mode in use not very long ago, by which people were cramped for hours and even days in a coach without springs worth calling by that name, and were jolted and tossed about over uneven roads, we conclude that traveling at the present time is a very luxurious thing. But what will it be when we can sit at an open window, and glide along at the rate of sixty miles an hour, without the fear of smoke or cinders; when electric bells are at hand leading to the inaccessible retreats where porters now secrete themselves safe from discovery; when we can start from our homes to take a car for Boston, as we now start to take an elevated train, knowing that, if we miss one car, another will be soon at hand; when electric incandescent lamps, which can not, in case of accident, scatter burning oil in all directions, shall fill the car with a mild and steady light; when dispatches can be received on board a train in motion as well as at an office; when the cars shall be heated and meals prepared by electric stoves which can not, in case of accident, set fire to the car—all the electricity needed for these and numberless other purposes being derived from the same convenient source—the conductor carrying the current which furnishes the propelling power?

That any such ideas as to what electricity can accomplish are visionary and impracticable may seem to be the case to some; that they are so in reality is not believed by many who have given the subject impartial study. Some of these believe that, in the very near future, electric cars will supplant horse-cars; and upon short lines like elevated roads, steam-locomotives; but that it will not be practicable for many years to run electrical cars upon long lines. Such may be the case. But it should be remembered that, in most instances in the history of industrial progress, the practical developments of meritorious systems have surpassed in rapidity and extent the expectations of even impartial men. A very high scientific authority in England once spoke very favorably of the idea of using steam-vessels for accomplishing short distances, and for river navigation, but laughed heartily over the suggestion of their ever going to sea, and offered publicly to eat the boilers and engines of the first one that should cross the Atlantic. Probably there are not many men who, in the light of what has recently been accomplished, would promise to eat the motor of the first electric car that should run from New York to Chicago.

PHOTOGRAPHING A STREAK OF LIGHTNING.

By GASTON TISSANDIER.

A BOHEMIAN observer, M. Robert Haensel, of Reichenberg, has succeeded in accurately photographing a flash of lightning. His pictures, of which he has taken several, show the light of the flash, under the form of long, continuous sparks, traversing the atmosphere. With the spark the landscape also is well produced, and a means is

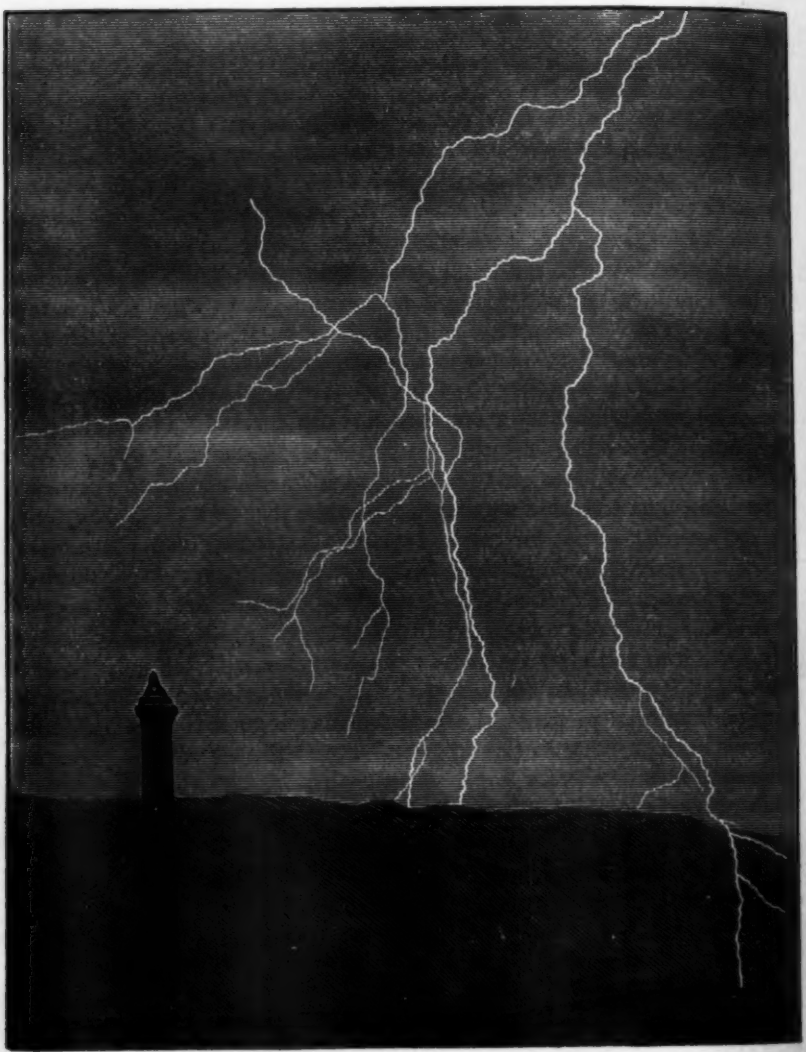

FIG. 1.

given for estimating the length of the luminous train, which, in one instance, is calculated to be seventeen hundred metres, or more than a mile.

Wheatstone demonstrated by direct experiments of great ingenuity that single flashes of lightning do not last more than a millionth of a second. We may judge from this of the wonderful sensibility of the new gelatine-bromide plates which permit the taking of correct views under these conditions.

M. Haensel has given a short account of the circumstances under which his photographs were taken and of the processes he employed. On the 6th of July, 1883, during a storm, when the sky was traversed

FIG. 2.

by frequent flashes of lightning, he turned his instrument at about ten o'clock in the evening toward that point whence the strongest flashes seemed to issue. The apparatus was furnished with the most sensitive gelatine-bromide plates, and the flash left its own impression upon them as it was formed. Out of ten plates that were exposed, he obtained only four photographs, of two of which we here give exact copies, taken from heliographic reproductions by M. Gillot, of Paris. The first figure represents two flashes. In the left one will be observed a double spark, which also appears triple in the middle. Simulta-

neously with this flash the sky was traversed by another, which also appears ramified in even a more complicated manner than its companion. The second figure represents in all its beauty a flash with many extensive and divergent ramifications.—*Translated for the Popular Science Monthly from La Nature.*

METHODS OF INSTRUCTION IN MINERALOGY.*

By M. E. WADSWORTH, Ph. D.,
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IN the present discussions concerning the relative merits of classical and scientific studies as factors in education, one point seems to be often lost sight of: the difference between instruction given for the purpose of disciplining the mind and that given for the purpose of imparting information. The former appears to be the chief function of our public schools, academies, seminaries, and colleges; the latter the principal object of technological and professional schools and graduate or university courses proper.

It would seem, then, that it is necessary for any one, seeking to replace any disciplinary study by something else, to show that the proposed new study will afford an equivalent amount in kind. In other words, if the scientist can not show that the studies he proposes to introduce into our colleges and high-schools possess, beyond the information given, a power of disciplining the mind, in certain valuable directions, equal to any other studies, his case had better be abandoned. Realizing this, it is proposed to show how instruction in mineralogy can be and has been given in such a way as to cultivate and develop faculties of the greatest value and use to any man, whatever may be his walk in life. Of necessity, personal experience must be referred to in this case, which is the excuse for the seeming egotism of this article.

It is intended, first, to show how this was accomplished in the elementary course in mineralogy in Harvard College, as given several years ago. This course extended throughout the college year, requiring of the students attendance upon three lectures a week, or their equivalents, and, in addition, at least six hours of laboratory work. Since it (like nearly all the courses in Harvard) was an elective, it was taken only by a limited number of students.

At the time of my acquaintance with it, as a pupil, the first two and a half months were devoted to crystallography, while determinative mineralogy occupied the rest of the year. The crystallography was taught by means of crystal models, with illustrations taken from natural crystals, and embraced certain of the mathematical princi-

* Abstract of a paper read before the Society of Naturalists of Eastern United States, New York, December 27, 1883.

ples; but the course was largely devoted to the drawing of figures of crystals. Nearly all of this instruction was of a kind that caused the pupil to do his work in a mechanical manner, following "thumb-rules" given by the instructor. The student evidently was not expected to understand the reasons for his work — the great object seemed to be to mechanically produce the most beautiful and perfect drawings; and on this part of the course itis not proposed to dwell.

The mineralogical instruction was given in the following manner: First, there had been chosen a set of the most important mineral species, amounting to over two hundred in all, with which it was thought best that the student should be familiar. A sufficient number of typical specimens of each species and its important varieties had been labeled and permanently arranged, according to Dana's "System of Mineralogy," in a set of drawers accessible to the student. The instructor, with the specimens before him and the students around him, proceeded to point out the essential characteristics of these minerals, calling attention mainly to those features which would distinguish each mineral from all others in the chosen set. It was not proposed to burden the pupil with long descriptions of each mineral, but rather to require him to know and understand that which separated each one from its fellows, and caused it to stand out distinct from them. To this end every means of determination that seemed essential was put in requisition, except quantitative analysis. If the crystalline form was sufficient, the student was not expected to go further. If the physical properties sufficed, that was all that was necessary; if not, then resort must be had to the blow-pipe, and even to the wet tests. The student was taught to do that which the practical mineralogist does—to determine his minerals by the shortest method consistent with accuracy—the method to vary according to the specimen. The pupil was taught to observe the color, streak, hardness, etc., to weigh the evidence in each case, and to decide according to the weight of the evidence. No guess-work was permitted, but some decisive test was required which should prove that the specimen belonged to the species to which it had been assigned. After a certain group had been passed over by the instructor —as, for instance, the picked species of the native elements, sulphides, etc., and sulpharsenites, etc., of Dana's system—each student was assigned a drawer containing specimens of these minerals, unlabeled and mixed together. These specimens were selected so as to be fair representatives of the species and varieties, but yet sufficiently difficult and varied to bring into play the student's faculties which it was desired to cultivate. As aids, the student was allowed his lecture-notes, Dana's "System of Mineralogy," and the lecture-drawers of labeled minerals.

After sufficient time had been given for the laboratory-work, each student was expected to be questioned, during the lecture-hour, upon such specimens as the instructor chose from his drawer. The student

was required not only to name the specimen, but also to give his proofs why this belonged to a certain species and not to any other.

After this laboratory work had been performed, the instructor passed on to the next group—the chlorides, etc., fluorides and oxides of Dana's system. Lectures with the succeeding laboratory work followed, but in the drawers for determination there were placed specimens not only of this group but also of the preceding group. This was followed throughout the year, so that the student was unable to lose sight of any species he had previously studied. Written examinations were occasionally interspersed, in which the student was required to determine a certain number of picked specimens that were placed before him, and write out the reasons for his determinations. This system of instruction, I believe, was devised by the teacher of the course at that time, Professor J. P. Cooke. After having endeavored to inform myself as to the methods of instruction in elementary mineralogy both in this country and in Europe, I have as yet failed to find one that, in my judgment, equals this, both for the mental discipline and the practical instruction it gives; and I take pleasure in acknowledging my great obligations and gratitude to Professor Cooke for the mineralogical instruction I received from him in that course.

When, in the process of time, this course passed under my charge, great modifications were made in it; the crystallography was reduced in amount and lithology added. By a different arrangement the crystallography was taught in six lectures. In these, by means of a few simple principles, the student was taught to recognize readily to which form the planes of any crystal belonged, no matter how many different forms might be represented. Further than this it did not seem practicable to go, without entering upon an extended course of instruction and practice in mathematical crystallography, which would have consumed the entire time of the course. However, it was found that the students were better trained for the practical application of crystallography to determinative mineralogy by this brief course than they had formerly been by the two and a half months' instruction previously given.

Another radical change was the substitution for the "general quiz" of all the students, at the lecture-hour, of an hour's oral examination for each student. Each one was required to arrange some hour in which he could meet the instructor alone in his room, with his (the student's) crystal models, or drawer of specimens, as the case might be. During that hour he was carefully questioned upon the material, and every effort was made to lead him to express his ideas clearly. He was cross-examined on every point, relating not only to general principles, but also to the particular specimens in hand. He was required to state what characters were upon the specimens, how he determined them, and what their relations were to others. If it was found that the student's methods were imperfect, his

logic defective, or that he had misunderstood anything in the lectures, every effort was made to set him right. The examination was really made a pleasant conversation between two friends, in which one constantly endeavored to draw the other out, place him at his ease, and enable him to tell what he knew. Methods of thought and work were the great objects, far more than correctly naming the specimens. In such an examination as this the student was obliged to depend upon his merits. The teacher must have indeed been a poor one if he could not in that hour find out, to a far greater extent than the student dreamed or suspected, what he knew and what his methods of thought and work were. Every effort was made to render the student an independent thinker, to cultivate in him accuracy and quickness of observation and readiness of perception, to lead him to rely upon himself, to weigh evidence, to reason closely, to form an opinion, and give his reasons therefor—to see, to be accurate, to reason, to judge, to decide. The time was also improved as a means of getting hold of him and establishing cordial relations with him; as well as to turn him unconsciously in the right direction, and to come into that close personal contact which it is so difficult to bring about in a large university, but which is so precious and valuable. Since these hourly examinations were repeated with each pupil for each group, the chief drawback was the tax upon the instructor's time and strength, as any one can readily realize when he considers that this species of mental gymnastics was kept up from six to ten hours a day, and that there were seven groups requiring from twenty-six to thirty hours in each group. It is to be borne in mind that this work was entirely voluntary on the instructor's part, but it paid in the results to the students, and in many of them it has influenced powerfully their after-life.

The students attending the course comprised freshmen, sophomores, juniors, seniors, graduates, specials, and scientific school students—a perfectly natural result from the extended elective system of Harvard. I am free to confess that, for a course like the one above described, I much prefer freshmen and sophomores to juniors and seniors. The reason is not far to seek. The prime objects of such a course are to cultivate observation and accuracy, train the powers of reasoning and judgment, and above all to beget in the student independence and freedom of thought. The previous training of the upper-class men had usually been such as to cramp and weaken whatever faculties in these directions they might have originally possessed, and hence it was exceedingly difficult to stimulate them to right methods of work and thought. This was strikingly exemplified in the case of those students who were thoroughly conversant with the blow-pipe, from their previous study of chemistry. It was with the greatest difficulty that they could be prevented from taking some one of the numerous artificial blow-pipe keys for the determination of minerals, shutting their eyes to all the physical characters, transforming them-

selves into mere wind-machines, and mechanically grinding out their results.

One question will naturally arise in the minds of every one: Can similar methods be applied in giving instruction for a limited time when the means and appliances for determination are of themselves much circumscribed? In one case this has been practically answered by myself, in giving instruction in the rudiments of mineralogy and lithology in the Museum of Comparative Zoölogy. The problem was to take dust-covered minerals and rocks that had accumulated through many years—some good, but most of them mere rubbish, the odds and ends of various collections—and give a two and a half months' course. From the necessity of the case, no blow-pipes could be used in the building, there were no crystal models, and the whole apparatus for qualitative tests was a bottle of hydrochloric acid and a few test-tubes which could be used in the cold. Streakers, magnifying-glasses, magnets, and a knife or file, with some broken glass, completed the outfit. The miscellaneous collection of minerals and rocks was washed and sorted, and such specimens as could be used were labeled and placed in drawers accessible to the students. With this material it was impossible to arrange test-drawers as described in the previous course. The instructor then directed the attention of the students to those physical and chemical characters of the specimens that they could make use of. The same general system was pursued as before, so far as the different conditions would permit—the object being the same, to impart valuable instruction together with mental training. The students, under the direction of the instructor, worked over the labeled drawers, and determined for themselves why the specimens were labeled as they were. At the end of the course a series of minerals and rocks was placed before each student, and he was required to determine them, writing out his reasons therefor. The result far exceeded my expectations. Out of thirty-eight students examined, comprising freshmen, sophomores, juniors, seniors, graduates, special and engineering students, thirteen took over ninety per cent, three of whom had the maximum mark; twelve obtained over eighty per cent, five over seventy per cent, four between fifty and sixty per cent, and four between ten and fifty per cent.

That this course afforded an intellectual discipline of advantage to the student has been shown, among various ways, by the testimony of one of the sophomore students. His time later was largely devoted to philosophical studies, including language and history, and after graduation he pursued the same studies at Harvard and in the best European universities. After his return from Europe and his establishment as an instructor in his favorite branches, he informed me that this brief course had been of permanent advantage to him in his later studies, and that it was one of the very few of the courses taken in college upon which he could look back with any satisfaction and be-

lieve it had materially aided him both in mental discipline and in methods of study. I speak of this simply to fortify my claim that mineralogy when rightly taught affords in certain directions a most valuable means of intellectual training.

In most localities, especially in regions of crystalline rocks, the teacher, even with very limited means, can usually procure many specimens of at least a few species, which he can arrange for his students, and practice them upon in such a manner as to bring into play the required faculties. This method can even be pursued with large audiences, if specimens enough can be obtained.

Besides exercising the pupils on the selected collection, they should be encouraged to seek the specimens themselves in the field. Every means possible should be taken to develop in them methods of thought and work that will bear fruit in their future life. Far less should be thought of training mineralogists than of training men.

In giving advanced instruction, the secret seems to be to bring the student up to the level of the instructor; to see that he has a broad and thorough knowledge of the principles and necessary data of the science; to point out to him the untrodden fields; to strengthen and exercise him so that he may walk without the teacher's aid. The great aim should be to render the student independent in his thought and work, to free him from a slavish following after mere weight of authority, and to beget in him a desire to seek truth for its own sake. He should be so trained and strengthened that, when away from the instructor's aid, he can walk in the untried grounds with a firm and steady step.

The preceding has not been given as of necessity the most perfect way, but simply as a way for reaching certain results.

Far more, indeed, depends upon the teacher and his spirit than upon the method, however valuable the latter may be.

It may also not be amiss to call attention to certain requirements in the teacher. That an original investigator in any science may be a poor instructor in that science is too well known to be disputed, but I believe it to be equally true, that no man can teach any science in spirit and truth—can produce upon his pupils the effect that ought to be produced—unless he has the spirit and knowledge of an investigator himself. In truth, it is confidently believed that no man can be a teacher of the highest order who has not walked in the temple of mystery itself, and wrung from Mother Nature some of her closely-guarded secrets. As well ask one who has only *read* about disease to properly teach medical students the *practice* of medicine as to ask one who has only *read* about any science to give *proper* instruction to his students in it. Yet this is the thing which the majority of our colleges are doing, and they fill their chairs as if they thought a thorough training in any science disqualified a man for teaching it. And then we are told that science-teaching is a failure! Is not the failure more in the teachers *chosen* than in the subjects?

PHYSIOLOGICAL SIGNIFICANCE OF VITAL FORCE.

By WILLIAM G. STEVENSON, M. D.

MODERN science has so extended the horizon of our mental perspective, has achieved such brilliant triumphs in so many departments of thought, and, on the basis of verified fact, has erected such an imposing superstructure of useful knowledge in the domain of inorganic nature, that some, rejecting the vitalistic theories of the past, have accepted the belief that the deeper mysteries of vital phenomena will, in a final analysis, be demonstrated to be but resultants of physical forces acting under the complex conditions of organization.

To investigate and interpret the varied phenomena of nature is the unquestioned prerogative of the human intellect; but science, having to do only with "particular orders of phenomena which exist in relation to the percipient mind" and are susceptible of verification, does not hope to solve the profound mysteries involved in the ultimate realities of either matter, energy, or life. With restless energy the human mind presses on in its search for truth, and brings from varied sources new facts to add to the sum of knowledge, until the conclusion is reached that matter is indestructible and energy persistent, and in the formulated laws of the "correlation and conservation of energy" the widest generalizations are made. In thus classifying and uniting the manifestations of matter and of life, whether morphological or physiological, under one general cosmic law, their explanation is made complete within the limits of the known.

Phenomena are explained, but the absolute remains unrevealed. The questions still are asked: What is gravity? What are chemical, electrical, and vital forces? What is the essential nature of matter, energy, and life? There is no oracle to answer.

The study of vital phenomena is difficult because of their complex character, and, in the absence of exact analysis, speculative philosophy has for many ages ventured different theories in explanation of their nature. In seeking to give the present status of physiological science on this important question, it is of interest to take a general historical retrospect, in order that the steps of progress may be observed.

The atomic philosophy, as taught by Democritus and Epicurus, recognized but one kind of matter, whose elements, by virtue of their various forms, had the property of diversified and endless combinations. This play of atoms, independent of an overruling intelligence, produced the worlds of inorganic and of organized matter, which move on in endless cycles and are obedient only to physical forces.

Plato regarded the intelligent soul as of dual character: one part, located in the body, being mortal and presiding over the appetites and

passions; the other part, located in the head, being immortal and the source of reason.

The nature of the function of the brain and of the nervous system was unknown to Aristotle, who thought the soul contained the body, having its mortal part located in the heart. He, as well as Plato, thought the "pneuma," or breath, was to cool the blood, and in some way act as an instrument of mind over bodily actions. The vital principle of all life-forms resides in a germ; "this principle, while it resembles heat, is not fire, but a spirit similar in nature to the sun and stars."

Hippocrates accepted the Pythagorean doctrine of the four elements, and from it developed his theory of four principal "humors" of the body. He taught the existence of an "intermediate nature," which, though distinct from the mortal soul or pneuma, was the source of vital activity.

The pneuma was deemed such an important factor in the explanation of vital phenomena, that a school called "Pneumatists" was founded in the first century of our era. It was not then known that the arteries contained blood, but they were regarded as the channels through which the pneuma passed throughout the body; and this pneuma was to Galen, A. D. 130, identical with the soul. For fourteen hundred years "pneumatism," under varied forms, was the accepted philosophic belief of the civilized world, and only in the latter part of the sixteenth century did anatomical study enable Sylvius, Fallopius, Fabricius, and Harvey, to modify the prevailing belief of bodily functions. Then it was that Paracelsus sought to explain vital phenomena through the agency of an "archæus" or demon, which, he affirmed, was located in the stomach, and presided over the processes of nutrition, separating the useful from the poisonous part of the food.

Van Helmont adopted the idea of an archæus, but thought it an immaterial though personal force or entity, which "presided over all bodily functions" and gave to each member of the body its own special "vital spirit." The consensus of all these vital spirits produced health, and their disagreement disease.

Van Helmont "discovered gaseous substances and identified the archæus itself with gas." He proclaimed the existence of a general bond of sympathy throughout the universe, because of the "vital spirits" which resided in all forms of matter.

Descartes regarded the body simply as a complex machine, acting under conditions of physical forces, and all the phenomena of life were but the products of their working. The soul, however, was a hihger and independent principle which, located in the pineal gland, made itself known by thought, and took its temporary abode in the body, simply as a spectator of vital functions.

Leibnitz, while admitting a harmony established by Divine power, denied to soul and body any reciprocal influence, saying: "The body goes on in its development mechanically, and the laws of mechanics

are never transgressed in its natural motions. Everything takes place in souls as though there were no body, and in the body everything takes place as though there were no soul."

Lord Bacon accepted the doctrine of "vital spirits" as applied to both animate and inanimate bodies.

Glisson believed in "vital spirits intermediate between the soul and organs," and regarded "irritability as a force of which perception and appetite are factors."

Stahl, in the eighteenth century, enunciated the doctrine that chemical forces and vital force not only differ from each other, but are antagonistic. Chemical forces are destructive of the living body, and are held in abeyance, and their disintegrating power is neutralized by a vital force which resides in the body and ministers to its functions. "This vital force, struggling against physical force, acts intelligently, upon a definite plan, for the preservation of the organism"; its triumph secures life, while the rule of the physical forces alone brings death. The theories of "vitalism" and "animism" thus took their places among the philosophic ventures of the age.

Borden, Barthez, and Grimaud, "representing the school of Montpellier," accepted "vitalism" but rejected "animism." The principle of life was believed to be distinct from the soul, though it was thought to operate independently of mechanical or chemical laws.

Haller inaugurated the inductive method in physiological science, and, by experiments, located irritability in the muscular tissue and sensibility in the nervous tissue.

Buffon explained vital phenomena through the instrumentality of "organic molecules" which, differing in form and nature, were indestructible and endowed with the "properties of vitality." These molecules, when associated, not only gave specific character to each part of the organism, and provided for its physiological activity, but became the perennial source of life.

In order to explain how the organic molecules became arranged into the specific forms of life, and preserved individual and type identity in nutrition and reproduction, Buffon projected his theory of "interior molds," by which, in connection with the "organic molecules," he sought to account for all the phenomena of the organic world. It was not until 1827, when the ovule in the ovarian follicle of mammalians was discovered by De Baer, that the theory of "organic molecules" and "interior molds" was overthrown. A single demonstrated fact destroyed the speculations of an age.

Bonnet's theory of "included germs" was another example of reasoning from premises that had not been verified, and the result was disastrous to the subjective method. He taught that the germs of all life-forms not only pre-existed in their first-created representative, but actually contained within themselves, already formed, all the parts of the future organism.

Logical deduction and scientific research, according to the beliefs and methods of the age, permitted such doctrines to receive for a time the approval of popular assent. But the spirit of inquiry was abroad in the world, and the advance of embryological science soon gave the demonstration that the doctrine of "included germs" had no foundation in fact, and so it was numbered with the errors of the past.

Cuvier, who had with such ability compared the structure of animal organs, and classified the facts of animal life in their statical or anatomical relationship, was a "vitalist," and thought the vital properties of the body a kind of entity—independent of physical or chemical forces.

Bichat sought, by a study of the tissues which composed the organs, to learn the nature of their functions, or the dynamics of the living body. He found that all the various kinds of tissue of the body, though differing in function, were endowed with two common properties—extensibility and contractility.

While he made phenomena depend on the properties of matter, he nevertheless followed Stahl as a "vitalist," and claimed that vital and physical properties are not only distinct from but antagonistic to each other: "The vital properties preserve the living body by counteracting the physical properties that tend to destroy it." Each class of phenomena is under distinct laws, and the conflict between them is active and constant. As one or the other triumphs, life or death results, and "health and disease are but the vicissitudes of the strife."

Life is, by Bichat, defined as "the group of functions that resist death," and is under the direct supervision of a special principle called at different times "soul," "archæon," "psyche," or "vital force." The philosophic theory which postulated this undetermined factor was known by the generic term of "vitalism," which, under Stahl and Bichat, took accurate definition, and deeply impressed its tenets upon the physical, chemical, and physiological sciences of the age.

Entities of some kind presided over the functions of life and the manifestations of matter. A "vital principle" ruled the organic world, and the phenomena of inorganic nature depended upon the presence of some "principle" which existed independent of the matter through which it displayed itself. Material particles, darting from luminous bodies into the eye, produced the sensation of light. Heat and cold depended upon the presence or absence of a material substance called "caloric." Electricity was a subtile, material agent, existing in a "latent" state in all substances, and manifesting great power when liberated from its repose. And so throughout the domain of chemical, physical, and biological phenomena, material entities existed and were manifested in all forms of inorganic and organic bodies, and yet were independent of them.

This was not an age for synthetic work; indeed, not even accurate analytic work, except in simple things, could be performed. These

are possible only when facts have been observed, and definite knowledge has been acquired in special directions. In the sixteenth century, alchemy, having failed to discover the philosopher's stone, sought to find chemical remedies for diseases. Crude theories were supported by a few facts wrongly interpreted.

Early in the seventeenth century Glauber states that salt is the origin of all things. Boyle argues against the theory that "salt, sulphur, and mercury are the principles of things," and makes heat a powerful factor in originating new bodies. Becher thought that metals consisted of earth, of which there were three kinds—fusible or stony, fatty or fluid, and a "something of which they became deprived on ignition." This "something" Stahl named "phlogiston," which is akin to "spirits" and "souls" of the alchemists.

The phlogistic theory of Stahl was without foundation in fact, and yet, based upon experimental data, it was a step upward in chemical research, and held the minds of all for over one hundred and fifty years, including such great names in the eighteenth century as Hales, Black, Scheele, Priestley, Cavendish, and Lavoisier. Then it was that the analytic method became more accurate. Black, with the balance, demonstrated that the ignition of the metals magnesium and calcium gave no evidence that a ponderable "caloric" entered into them, but, to the contrary, a peculiar "fixed air" was expelled from them, which rendered them lighter than before they were burned.

The foundation of quantitative chemistry was thus laid, and the existence of "imponderable" agents in nature questioned. The discovery of "dephlogisticated air" by Priestley, the investigation of gases by Cavendish, of heat and fire by Scheele, and of insoluble minerals by Bergman—by means of the blow-pipe—were important additions to chemical knowledge, and enabled Lavoisier to generalize the facts already discovered. He announced a new theory of combustion, and, by questioning the existence of phlogiston, and showing that "principles should not be assumed where they could not be detected," revolutionized chemistry and gave it a new impulse, which has been quickened by every discovery since made.

Analysis of inorganic bodies increased, new facts accumulated, and new interpretations of phenomena were given, until the atomic theory, first suggested by Dalton in 1804, was promulgated under the great generalization known as the law of Avogadro or Ampère, which makes "equal volumes of all substances, when in a state of gas, and under like conditions, contain the same number of molecules."

This was the birth of modern chemistry, and, though it received attention when first enunciated in 1811, its far-reaching principles of truth were neither fully understood nor accepted for half a century afterward.

Chemistry, free from the errors of the past, now seeks to discover in the organic world the relations of different substances, as it has

sought to know their relations in inorganic nature, and already the evidence is prophetic of wonderful results.

In physical philosophy, "Stahlism" received its mortal wound at the close of the last century by the experiments of Rumford and Davy, which negated the theory of "caloric" and demonstrated heat to be a "mode of motion."

This new doctrine, though founded on a demonstrated fact, was not complete until 1850, when Joule, having determined the mechanical equivalent of heat and established the law of thermo-dynamics, made possible the classification of facts determined by Young, Melloni, Faraday, Liebig, Mayer, Grove, Helmholtz, Carpenter, Tyndall, Henry, and others, which enabled the deduction to be made of the universal laws of the "correlation and conservation of energy."

In inorganic nature, unity, under law, is an accepted fact, and analysis and synthesis harmonize as to causes and effects; but in the organic world there are yet many unknown quantities, and the progress in solving the mysteries of life-action is necessarily slow, because of their complex character.

To some, "vitalism" yet maintains its position in the philosophic realm of organization, and a "vital force," independent of and antagonistic to physical force, yet presides over the manifestations of organic bodies. This, if true, necessitates "two distinct sciences and two distinct orders in nature," which, though related, are not reciprocal. This view is not in harmony with either chemical, physical, or biological science of the present day, and stands in direct contradiction to the accepted doctrine of the correlation and conservation of energy.

Whatever may be the essential nature of the ultimate life-principle —with which science has nothing to do—it can not be denied that life-phenomena are presented to us only through forms of matter. Matter, or material organization, is, therefore, so far as human knowledge goes, an absolute condition upon which all life-manifestations depend, and to assert, as do the "vitalists," that this vital energy—an agency which can not be verified, though dependent upon a material condition for a display of its action—is not related to it, but is independent of it and under distinct and antagonistic laws, is an assumption at variance with scientific truth and reason.

Doubtless one common source of error in the minds of the disciples of "vitalism" is inaccurate definition, confounding, as they do, the scientific meaning of a term with its philosophical or metaphysical significance. Thus, the term "life," when applied to the higher animals, is, to the metaphysical philosopher, often related to, or made synonymous with, the "soul"; while to the physiologist it refers only to the sum of phenomena arising in organized bodies. If what "can not be explained by chemistry or physics" constitutes the vital functions, then, by simply eliminating the known or non-vital factors, we may easily learn the exact amount of the vital element.

Science has already "banished the vital force from the entire province of organic chemical compounds, proving them to be subject to the same physical and chemical forces which determine the composition of mineral matter," and it now remains to test by analysis and synthesis the problem of organization itself.

It may very properly be asked, If the vital force has been banished from the entire province of organic chemical compounds, as asserted and demonstrated, in what it now resides, where is it located and what are its functions?

Chemical science has already demonstrated that all "proximate principles" and tissues of an organized body are, in an ultimate analysis, reducible to some of the elementary substances; and as, in inorganic bodies, morphological differences result from the various combinations of the ultimate elements, so, too, is it with organized bodies. So far as form alone is concerned, it is no more difficult to understand why organic compounds, under conditions of vital relations, take on the special form of a single speck of bioplasm in one case, of a vegetable in another, or of an animal form in another case, than it is to understand why the same elements will produce substances either allotropic or isomeric.

The phenomena are classified and thus explained, but in neither example is the ultimate nature or condition which causes the morphological difference known. There is no known force in nature capable of lifting the elements to the plane of animal organisms, except through the intermediate planes of the mineral and the vegetable kingdoms. Chemism is sufficient to form the mineral kingdom from the simple elements, which are under physical force alone. As the elementary combinations necessary to form a mineral involve an expenditure of force, which is transformed from a lower to a higher expression, so, in resolving the mineral back again to its elementary state, the force conserved in a higher state represents the original larger but weaker force of lower grade. The same is true when chemical compounds, as represented in the mineral kingdom, are lifted to the plane of the vegetable kingdom, or when the members of this class are raised to the highest class of the animal kingdom. In all cases the higher conditions depend upon the conditions of the next lower plane; and the conserved forces of the higher plane, when liberated by decomposition, represent the special functions of the organization.

There is not a phenomenon in animal life, from the earliest stage of germ-growth to the final stage of human development, but is susceptible of classification. The monera—mere specks of bioplasm—organisms without organs, so far as can be determined in their power to move, to receive nourishment, to react on external impressions and to reproduce their kind—not only manifest the fundamental properties of life, but display them under conditions so simple, so free from all

morphological complications, that the way seems prepared by nature herself for the inquirer to enter the portals which open into the mysteries of life. They are on the border-land of the living and the not-living, blending on the one side with colloidal matter and on the other with vegetable forms, all so intimately related with simple "matter" as to justify if not necessitate the conclusion of genetic correlation.

We see this simple hyaline particle of bioplasm expand and contract, accompanied with chemical composition and decomposition, and the conclusion is irresistible that these simplest forms of motion, expansion and contraction, follow in orderly sequence of cause and effect.

Motility, arising from chemical disintegration and reintegration, represents, therefore, a fundamental expression of living organized matter, and impresses us with the idea of energy transformed. Indeed, all the functions of the higher organisms testify to the truth of the proposition that every manifestation of energy of organized bodies has its mechanical equivalent, and follows an orderly sequence of events.

The nutrition of the body, through all the intricate processes of external and internal digestion under the action of the digestive ferments, involves only physical and chemical forces in the transformation of the various foods received. The entire animal body is composed of modified protoplasm, as represented in the three classes known as proteids, carbohydrates, and fats, with their respective derivatives.

The proteids are exceedingly complex in character, and are not as yet definitely classified among organic compounds. They unite with acids and alkalies, and yet "do not play the part of an acid toward the base," or conversely. They are not crystallizable, and, having no combining equivalent, do not possess an absolute ultimate constitution, and therefore their molecular reactions and changes in the body can not be expressed by exact chemical symbols.

Here, then, we see the formidable list of "proximate principles" that are known to belong to the animal body as nutrient elements, and which are necessary for tissue development. They are all organic compounds, from which science has "banished the vital force" by "proving them to be subject to the same physical and chemical forces which determine the composition of universal matter." Where, then, shall we seek this "indefinable something" which exists and acts in the organism independent of and antagonistic to the physical and chemical forces of nature, as affirmed by the doctrines of "vitalism" taught by Stahl and Bichat?

The position held by these distinguished men and their followers has been demonstrated to be untrue, because, whatever may be the essential nature of this vital force, certain it is that it is known only by and through its manifestations. These present themselves to the mind only through organizations which immediately depend on chemi-

cal and physical forces for those proximate constituents which go to nourish and build up the tissues and enable the organs of the body to perform their respective functions.

In nutrient action, by which lifeless material or pabulum is transformed into living tissues, evidence of this vital entity should be discovered, if anywhere, for here we have the primal seat of life, the very fountain of genetic power.

Analysis, however, finds room for it in nutrient action no more than in the mysteries which lie concealed in every expression of energy throughout nature's domain. Why will friction of glass produce a condition or property which will repel pith-balls, while friction of sealing-wax produces a condition which will attract them? Are these movements caused by some kind of life-principle developed in so simple a way? No; they come from positive and negative electricity evolved by friction, and, with this answer, science asserts that the explanation is complete. When asked, What is electricity, beyond a special display of energy? there is no answer.

If we question the various organic functions of the body, physical and chemical forces alone confront us. A muscle contracts according to mechanical laws, and its work is expressed in mechanical equivalents. Electric tension is lost, heat is evolved, carbon dioxide appears, and the muscular tissue, before neutral in reaction, is now acid. Whatever may be the nature of the vital force, if such there be, operating in muscular contraction, it at least is not independent of physical and chemical forces, and the evidence is cumulative that these will alone explain the phenomenon. Respiration is purely a chemical process, in harmony with the laws of gaseous diffusion. Circulation, with its pumps, pipes, and valves, is an hydraulic operation. Absorption is osmotic, and a similar selective affinity for special things is exhibited in inorganic material as well as in animal membranes.

There seems no good reason why we should hesitate to regard the vital force as correlated with the physical forces known to us as heat, light, electricity, and actinism. That some relation exists there can be no doubt, for the effect of physical forces upon organic life is marked, and their energy is made potential in the tissues of both vegetables and animals. This potential energy is, after a time, transformed into active energy, and new phenomena result.

Organic forms do not generate energy, they simply transform or evolve it from that which has been supplied from the outer world. Heat in the body results from combustion the same as in a furnace.

Contractility is a special function of muscular tissue, and is independent of nerve-force. This attribute exists in the tissue for a time after death, lasting longer in cold-blooded than in warm-blooded animals, because of the slowness of the process of the destructive assimilation of the tissues. Longet demonstrated that contractility is closely related to the supply of arterial blood in the capillary vessels, for, on

diminishing the supply, contractility was lessened, and the temperature of the muscles reduced; while Matteucci proved that increased heat accompanies muscular contraction. The heat produced by muscular contraction is divided into two complementary portions, one part appearing as sensible heat, and the other part being converted into mechanical work.

It matters not whence comes the heat, whether from the chemical transformations which take place in the body, or from the sun-force which has for ages lain locked in the coal-strata of the earth, when liberated or made dynamic, it represents a definite amount of mechanical power.

Nerve-energy is transformed into motion, as evidenced in muscular action; it is also transformed into heat, but it is not known whether it is an immediate or a secondary result. There are some instances recorded which seem to show its transformation into light, and it is well known that in certain animals electricity is the direct result of its metamorphosis.

From these data the conclusion seems authorized that at least a partial correlation exists between the physical forces and the energy resulting from nerve-action. I say a partial correlation, because, while the evidence may permit the conclusion that nerve-force is transformed into motion, heat, light, and electricity, it does not yet authorize the assertion that these can be reconverted into nerve-force.

This correlation doubtless extends to the higher manifestations of nerve-energy, feeling, and thought, for their exercise causes disintegration of nerve-tissue, as shown by the excreted products of decomposition and increased muscular action, as evidenced in the increased circulation of the blood. Physical conditions, therefore, determine mental results. The higher nerve-tissue of the brain operates under physical and chemical conditions in its nutrition, the same as does the tissue of any other organ, and hence its transformed energy, as expressed in nervous or mental action, has its physiological representation and measurable force.

To extend this subject further in the line of analysis, though it might be interesting, is unnecessary for the object proposed, which is to show that chemical, physical, and biological sciences have overthrown the vitalistic doctrines of the past, and demonstrated by analysis a relationship between the forces which rule the inorganic world and the "vital force" which is manifested in living forms. At this point the question is properly asked, if chemical synthesis confirms the results and conclusions of chemical analysis.

If the morphology and physiology of organisms are the products simply of physical molecules under chemical and physical forces which are revealed by analysis, then the assumption seems justified that synthesis, by combining these same molecules and restoring these same forces, should be able to reproduce the forms and functions of life.

Synthesis requires exact knowledge of all the elements and forces involved in the object of its investigation, and looks to the inductive or analytic method to furnish these data. There must be no unknown quantities in the problem to be solved, for synthesis seeks not to build from the unknown but only to re-form the known. Hence it properly awaits to receive verified facts from chemical analysis, which has yet been able to compass but a fractional part of the organic compounds.

Chemical elements are the basis of chemical science; they are neither produced nor destroyed, but are the enduring and constant factors in the many series of changes in the properties of matter, which represent the desideratum of this science. And yet the knowledge of molecules is very meager; the weights of but a few are known, even among the commonest elements and compounds; and but little account has been taken of atomic motion, which furnishes the most perfect explanation of chemical reaction.

Of the highly complex series of albuminoid substances, which neither crystallize nor possess any combining equivalent, and therefore can not be expressed by exact symbols, analytic chemistry knows but little, and hence it would be in vain to attempt their reproduction by synthesis. Notwithstanding our ignorance of essential facts, the progress of synthetic chemistry has been great, and the prospect is favorable for more brilliant achievements in the future.

Wöhler, in 1828, first, by synthesis, formed urea from ammonia cyanate. It was claimed by the critics that urea, being a nitrogenous metabolite, a product of animal decomposition, was a mineral, rather than an element of the animal tissues; but when Fownes, in 1841, prepared cyanogen itself direct from its elements, and, from this salt, urea, the fact was recognized and accepted, although it was affirmed that a "vital force" was necessary to account for the more complicated organic compounds, of which series urea was a member having only simple combinations. This was disproved by Berthelot in 1856, when he obtained the potassium salt of formic acid. Then followed the production of acetylene, marsh-gas, ethylene, and other hydrocarbons, from inorganic materials. Marsh-gas was converted into methyl alcohol, and ethylene into ethyl alcohol, and from these alcohols formic and acetic acids were made.

Startling as these results were, the substances formed were, relatively, simple in nature, and the "vital force" still ruled in the more complicated bodies of organic origin.

Synthetic work continued to achieve brilliant results and added to its list of vegetable compounds oxalic, valeric, malic, citric, tartaric, and salicylic acids, the oils of garlic, mustard, and wintergreen, also conine, alizarine, and indigo.

Of animal compounds, leucin, creatin, sarcosin, and taurin are added to the large and growing list of substances from which analysis and synthesis have banished the vital force, and harmonized the facts

of their existence with the physical and chemical forces of the inorganic world.

Over one thousand organic compounds, which but a few years since were supposed to be formed within the vegetable or animal body only by the action of a "vital force," are now produced synthetically from the elements which constitute them, and "there is every reason to expect," says the conservative but able author of "The New Chemistry," Professor Cooke, "that in the no distant future the chemist will be able to prepare, in his laboratory, both the material of which the cell is fashioned and the various products with which it becomes filled during life."

It is true that the knowledge of man has not yet enabled him to make a vegetable or an animal cell, but this is no evidence in favor of a "vital force" *per se*, but an indication of ignorance relative to the ultimate constitution of the cell. Indeed, pseudo-organic forms, which resemble living cells, having heterogeneous contents, and true inclosing membranes possessing dialyzing power, have already been reported as produced by Monnier and Vogt.

It is well, however, to remind ourselves of the fact that the "cell," as commonly understood, embracing a cell-wall and an internal nucleus, represents in itself an advanced condition of organization, and not, as is so often inferred, the most primitive and simplest of life-forms. "Cell," in biology, "is a technical term used to denote a unit of living tissue," and the fact that the chemist can not make it is not proof that an independent life-principle resides in it, but is proof of ignorance of its organic formation.

If the fact of a "vital force," distinct from physical and chemical forces, is to be established because of inability to make by synthesis a living cell, then, in logical fairness, should this force, or some other equally independent of physical and chemical laws, be declared to preside over the genesis and potencies of those inorganic elements and bodies which thus far have defied, not synthesis only, but analysis also.

In germinal matter is found the apparent seat of life, for this it is that transforms pabulum to build the tissues at first, and in it lies the potency of restoring to physical completeness portions of the body that may be injured or diseased. The repair of living tissues after mutilation is not, however, positive evidence of the existence of a special principle, for the same action occurs in inorganic materials.

Pasteur records the fact that "when a crystal is broken on any one of its faces, and replaced in the fluid of crystallization, we remark that while the crystal increases in all directions by the deposit of crystalline particles, a very decided simultaneous action takes place at the broken or injured part, and this action suffices in a few hours, not merely for the general, regular formation of increase over all parts of the crystal, but also for the restoration of regularity in the injured

part." Shall we ascribe a "vital principle" to the unorganized crystal as well as to the organized vegetable or animal tissue?

The mysteries of nature are not all confined to life-expressions. Who shall explain the ultimate nature of crystallization, which, under the laws of fixed axial ratios, gives to each variety such definite and invariable form? Who shall explain the flower's perfume? Where is the "vital force" in the seed which lies for ages in the tomb of some Pharaoh? Does "vital force," as an independent entity, which works contrary to physical and chemical laws, thus imprison itself and voluntarily submit to what must be, to it, a death? If it acts independently of the physical forces of nature, why has it not furnished evidence thereof in some way or at some time? How is life made active in this seed so long dried and practically dead? Not by any occult influence at discord with organic growth, but simply by environing the seed with conditions favorable to physical well-being. Heat, light, and moisture—all physical and chemical agents—soon revivify this seed, and evidence is added to sustain the proposition that, while "the present state of knowledge furnishes us with no link between the living and the not-living," yet are both actuated by forces of the same kind. "Vital force," therefore, is, in reality, only another term for the properties of matter; it denotes simply the causes of certain great groups of natural operations, as we employ the terms "electricity" and "electrical force" to denote others. But to use the term "vitality" or "vital force" in the sense of an entity, which acts as an efficient cause of vital phenomena, is an assumption as absurd as to assume that "'electric,' 'attractive,' and 'chemical' forces are entities which determine the phenomena of electricity, chemism, and gravitation."

"If we knew all the laws of the composition of matter, and all the changes of which it is capable, every phenomenon which any given substance presents must be caused either by something taking place in the substance or by something taking place out of it, but acting upon it. Those mysterious forces, whether they be emanations from matter or whether they be merely properties of matter, must, in an ultimate analysis, depend either on the internal arrangement or on the external locality of their physical antecedents. However convenient, therefore, it may be, in the present state of our knowledge, to speak of vital principles, imponderable fluids, and elastic ethers, such terms can only be provisional, and are to be considered as mere names for that residue of unexplained facts which it will be the business of future ages to bring under generalizations wide enough to cover and include the whole."

As mechanical energy manifests different powers and results as it operates through differently constructed mechanisms, so vital energy becomes more complex in its manifestations as the organism through which its work is displayed is more complicated in structure.

Jevons has well defined the physiological significance of "vital

force" thus: "We are at freedom to imagine the existence of a new agent, and to give it an appropriate name, provided there are phenomena incapable of explanation from known causes. We may speak of vital force as occasioning life, provided that we do not take it to be more than a name for an undefined something giving rise to inexplicable facts, just as the French chemists called iodine the substance *x*, so long as they were unaware of its real character and place in chemistry. Encke was quite justified in speaking of the resisting medium in space so long as the retardation of his comet could not be otherwise accounted for.

"But such hypotheses will do much harm whenever they divert us from attempts to reconcile the facts with known laws, or when they lead us to mix up discrete things.

"Because we speak of vital force we must not assume that it is a really existing physical force like electricity. We do not know what it is; we have no right to confuse Encke's supposed resisting medium with the bases of light without distinct evidence of identity. The name protoplasm, now so familiarly used by physiologists, is doubtless legitimate so long as we do not mix up different substances under it, or imagine that the name gives us any knowledge of the obscure origin of life. To name a substance protoplasm no more explains the infinite variety of forms of life which spring out of the substance than does the vital force which may be supposed to reside in the protoplasm. Both expressions are mere names for an inexplicable series of causes which, out of apparently similar conditions, produce the most diverse results."

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXVI.

THERE is one more constituent of animal food that demands attention before leaving this part of the subject. This is the fat. We all know that there is a considerable difference between raw fat and cooked fat; but what is the *rationale* of this difference? Is it anything beyond the obvious fusion or semi-fusion of the solid?

These are very natural and simple questions, but in no work on chemistry or technology can I find any answer to them, or even any attempt at an answer. I will therefore do the best I can toward solving the problem in my own way.

All the cookable and eatable fats fall into the class of "fixed oils," so named by chemists to distinguish them from the "volatile oils," otherwise described as "essential oils." The distinction between these two classes is simple enough. The volatile oils (mostly of vegetable

origin) may be distilled or simply evaporated away like water or alcohol, and leave no residue. The fixed oils similarly treated are dissociated more or less completely.

Otherwise expressed, the boiling-point of the volatile oils is below their dissociation-point. The fixed oils are those which are dissociated at a temperature below their boiling-point.

My object in thus expressing this difference will be understood upon a little reflection. These volatile oils, when heated, being distilled without change are uncookable; while the fixed oils if similarly heated suffer various degrees of change as their temperature is raised, and may be completely decomposed by steady application of heat in a closed vessel without the aid of any other chemical agent than the heat itself. This "destructive distillation" converts them into solid carbon and hydrocarbon gases, similar to those we obtain by the destructive distillation of coal.

If we watch the changes occurring as the heat advances to this complete dissociation-point, we may observe a gradation of minor or partial dissociation proceeding gradually onward, resembling that which I have already described as occurring when sugar is similarly treated (see No. XIII of this series).

But in ordinary cooking we do not go so far as to carbonize the fat itself, though we do brown or partially carbonize the membrane which envelops the fat. What, then, is the nature of this minor dissociation, if such occurs?

Before giving my answer to this question, I must explain the chemical constitution of fat. It is a compound of a very weak base with very weak acids. The basic substance is glycerine, the acids (not sour at all, but so named because they combine with bases as the actually sour acids do) are stearic acid, palmitic acid, oleic acid, etc., and bear the general name of fatty acids. They are solid or liquid, according to temperature. When solid, they are pearly, crystalline substances; when fused, they are oily liquids.

To simplify, I will take one of these as a type, and that the one which is the chief constituent of animal fats, viz., stearic acid. I have a lump of it before me. Newly broken through, it might at a distance be mistaken for a piece of Carrara marble. It is granular like the marble, but not so hard, and, when rubbed with the hand, differs from the marble in betraying its origin by a small degree of unctuousness, but can scarcely be described as greasy.

I find by experiment that this may be mixed with glycerine without combination taking place; that when heated with glycerine just to its fusing-point, and the two are agitated together, the combination is by no means complete. Instead of obtaining a soft, smooth fat, I obtain a granular fat, small stearic crystals with glycerine among them. It is a *mixture* of stearic acid and glycerine, not a chemical compound; it is stearic acid and glycerine, but not a stearate of glycerine.

A similar separation is what I suppose to occur in the cooking of animal fat. I find that mutton-fat, beef-fat, or other fat when raw, is perfectly smooth, as tested by rubbing a small quantity, free from membrane, between the finger and thumb, or by a still more delicate test of rubbing it between the tip of the tongue and the palate. But dripping, whether of beef, or mutton, or poultry, is granular, as anybody who has ever eaten bread and dripping knows well enough, and the manufacturers of "butterine," or "bosch," know too well, as the destruction or prevention of this granulation is one of the difficulties of their art.

My theory of the cookery of fat is simply that heat, when continued long enough, or raised sufficiently high, effects an incipient dissociation of the fatty acids from the glycerine, and thus assists the digestive organs by presenting the base and the acids in a condition better fitted (or advanced by one stage) for the new combinations demanded by assimilation. Some physiologists have lately asserted that the fat of our food is not assimilated at all—not laid down again as fat, but is used directly as fuel for the maintenance of animal heat. If this is correct, the advantage of the preliminary dissociation is more decided, for the combustible portion of the fat is its fatty acids; the glycerine is an impediment to combustion, so much so that the modern candle-maker removes it, and thereby greatly improves the combustibility of his candles.

It may be that the glycerine of the fat we eat is assimilated like sugar, while the fatty acids act directly as fuel. This view may reconcile some of the conflicting facts (such as the existence of fat in the carnivora) that stand in the way of the theory of the uses of fat food above referred to, according to which fat is not fattening, and those who would "Bant" should eat fat freely to maintain animal heat, while very abstemious in the consumption of sugar and farinaceous food.

The difference between tallow and dripping is instructive. Their origin is the same; both are melted fats—beef or mutton fats—and both contain the same fatty acids and glycerine, but there is a visible and tangible difference in their molecular condition. Tallow is smooth and homogeneous, dripping decidedly granular.

I attribute this difference to the fact that, in rendering tallow, the heat is maintained no longer than is necessary to effect the fusion; while, in the ordinary production of dripping, the fat is exposed in the dripping-pan to a long continuance of heat, besides being highly heated when used in basting. Therefore the dissociation is carried further in the case of the dripping, and the result becomes sensible. I have observed that home-rendered lard, that obtained in English farm-houses, where the "scratchings" (i. e., the membranous parts) are frizzled, is more granular than the lard we now obtain in such abundance from Chicago and other wholesale hog-regions. I have not witnessed the lard-rendering at Chicago, but have little doubt that

economy of fuel is practiced in conducting it, and therefore less dissociation would be effected than in the domestic retail process.

Some of the early manufacturers of "bosch" purified their fat by the process recommended and practiced by the French Academicians MM. Dubrunfaut and Fua (see "Comptes Rendus," vol. lxxi) during the siege of Paris, when they and others read papers on the manufacture of "siege-butter" without the aid of the dairy. This consisted in frying the refuse fat from slaughter-houses until the membranous matter and other impurities were carbonized, and thus could be strained away. I wrote about it in 1871, and consequently received some samples of artificial butter thus made in the midlands. It was pure fat, perfectly wholesome, but, although colored to imitate butter, had the granular character of dripping. Since that time great progress has been made in this branch of industry. I have lately tasted samples of pure "bosch" or "oleomargarine" undistinguishable from churned cream or good butter, though offered for sale at 8½*d.* per pound in wholesale packages. In the preparation of this I understand high temperatures are carefully avoided, and by this means the smoothness of pure butter is obtained. I mention this now merely in confirmation of my theory of the *rationale* of fat-cookery, but shall return to this subject of "bosch" or "butterine" again, as it has considerable intrinsic interest in reference to our food-supplies, and should be better understood than it is.

XXVII.

The cookery of milk is very simple, but by no means unimportant. That there is an appreciable difference between raw and boiled milk may be proved by taking equal quantities of each (the boiled sample having been allowed to cool down), adding them to equal quantities of the same infusion of coffee, then critically tasting the mixtures. The difference is sufficient to have long since established the practice among all skillful cooks of scrupulously using boiled milk for making *café au lait*. I have tried a similar experiment on tea, and find that in this case the cold milk is preferable. Why this should be, why boiled milk should be better for coffee and raw milk for tea, I can not tell. If any of my readers have not done so already, let them try similar experiments with condensed milk, and I have no doubt that the verdict of the majority will be that it is passable with coffee, but very objectionable in tea. This is milk that has been very much cooked.

The chief definable alteration effected by the boiling of milk is the coagulation of the small quantity of albumen which it contains. This rises as it becomes solidified, and forms a skin-like scum on the surface, which may be lifted with a spoon and eaten, as it is perfectly wholesome and very nutritious.

If all the milk that is poured into London every morning were to

flow down a single channel, it would form a respectable little rivulet. An interesting example of the self-adjusting operation of demand and supply is presented by the fact that, without any special legislation or any dictating official, the quantity required should thus flow with so little excess that, in spite of its perishable qualities, little or none is spoiled by souring, and yet at any moment anybody may buy a pennyworth within two or three hundred yards of any part of the great metropolis. There is no record of any single day on which the supply has failed, or even been sensibly deficient.

This is effected by drawing the supplies from a great number of independent sources, which are not likely to be simultaneously disturbed in the same direction. Coupled with this advantage is a serious danger. It has been unmistakably demonstrated that certain microbia (minute living abominations) which disseminate malignant diseases may live in milk, feed upon it, increase and multiply therein, and by it be transmitted to human beings with very serious and even fatal results.

I speak the more feelingly on this subject, having very recently had painful experience of it. One of my sons went for a holiday to a farm-house in Shropshire, where many happy and health-giving holidays have been spent by all the members of my family. At the end of two or three weeks he was attacked by scarlet fever, and suffered severely. He afterward learned that the cow-boy had been ill, and further inquiry proved that his illness was scarlet fever, though not acknowledged to be such; that he had milked before the scaling of the skin that follows the eruption could have been completed, and it was therefore, most probable, that some of the scales from his hands fell into the milk. My son drank freely of uncooked milk, the other inmates of the farm drinking home-brewed beer, and only taking milk in tea or coffee hot enough to destroy the vitality of fever-germs. He alone suffered. This infection was the more remarkable, inasmuch as a few months previously he had been assisting a medical man in a crowded part of London where scarlet fever was prevalent, and had come in frequent contact with patients in different stages of the disease.

Had the milk from this farm been sent to London in the usual manner in cans, and the contents of these particular cans mixed with those of the rest received by the vender, the whole of his stock would have been infected. As some thousands of farms contribute to the supplying of London with milk, the risk of such contact with infected hands occurring occasionally in one or another of them is very great, and fully justifies me in urgently recommending the manager of every household to strictly enforce the boiling of every drop of milk that enters the house. At the temperature of 212° the vitality of all dangerous germs is destroyed, and the boiling-point of milk is a little above 212°. The temperature of tea or coffee, as ordinarily used,

may do it, but is not to be relied upon. I need only to refer generally to the cases of wholesale infection that have recently been traced to the milk of particular dairies, as the particulars are familiar to all who read the newspapers.

It is an open question whether butter may or may not act as a dangerous carrier of such germs; whether they rise with the cream, survive the churning, and flourish among the fat. The subject is of vital importance, and yet, in spite of the research-fund of the Royal Society, the British Association, etc., we have no data upon which to base even an approximately sound conclusion.

We may theorize, of course; we may suppose that the bacteria, bacilli, etc., which we see under the microscope to be continually wriggling about or driving along, are doing so in order to obtain fresh food from the surrounding liquid, and therefore that, if imprisoned in butter, they would languish and die. We may point to the analogies of ferment-germs which demand nitrogenous matter, and therefore suppose that the pestiferous wanderers can not live upon a mere hydrocarbon like butter. On the other hand, we know that the germs of such things can remain dormant under conditions that are fatal to their parents, and develop forthwith when released and brought into new surroundings. These speculations are interesting enough, but in such a matter of life and death to ourselves and our children we require positive facts, direct microscopic evidence.

In the mean time the doubt is highly favorable to *bosch*. To illustrate this, let us suppose the case of a cow grazing on a sewage-farm manured from a district on which enteric fever has existed. The cow lies down and its teats are soiled with liquid containing the germs which are so fearfully malignant when taken internally. In the course of milking, a thousandth part of a grain of the infected matter containing a few hundred germs enters the milk, and these germs increase and multiply. The cream that rises carries some of them with it, and they are thus in the butter, either dead or alive, we know not which, but have to accept the risk.

Now, take the case of bosch. The cow is slaughtered. The waste fat, that before the days of palm-oil and vaseline was sold for lubricating machinery, is skillfully prepared, made up into two-pound rolls, delicately wrapped in special muslin or prettily molded and fitted into "Normandy" baskets. What is the risk in eating this?

None at all, provided always the bosch is not adulterated with cream-butter. The special disease-germs do not survive the chemistry of digestion, do not pass through the glandular tissues of the follicles that secrete the living fat, and therefore, even though the cow should have fed on sewage-grass, moistened with infected sewage-water, its fat would not be poisoned.

What we require in connection with this is commercial honesty, that the thousands of tons of bosch now annually made be sold as

bosch, or, if preferred, as "oleomargarine," or "butterine," or any other name that shall tell the truth. In order to render such commercial honesty possible to shopkeepers, more intelligence is demanded among their customers. A dealer, on whom I can rely, told me lately that if he offered the bosch or butterine to his other customers as he was then offering it to me at 8½*d.* per pound in twenty-four-pound box, or 9*d.* retail, he could not possibly sell it, and his reputation would be injured by admitting that he kept it; but that the same people who would be disgusted with it at 9*d.* will buy it freely at double the price as prime Devonshire fresh butter; and he added, significantly, "I can not afford to lose my business and be ruined because my customers are fools." To pastry-cooks and others in business, it is sold honestly enough for what it is, and used instead of butter.

Before leaving the subject of animal food I may say a few words on the latest and perhaps the greatest triumph of science in reference to food-supply—i. e., the successful solution of the great problem of preserving fresh meat for an almost indefinite length of time. It has long been known that meat which is frozen remains fresh. The Aberdeen whalers were in the habit of feasting their friends on returning home on joints that were taken out fresh from Aberdeen and kept frozen during a long Arctic voyage. In Norway, game is shot at the end of autumn, and kept in a frozen state for consumption during the whole winter and far into the spring.

The early attempts to apply the freezing process for the carriage of fresh meat from South America and Australia by using ice, or freezing mixtures of ice and salt, failed, but now all the difficulties are overcome by a simple application of the great principle of the conservation of energy, whereby the burning of coal may be made to produce a degree of cold proportionate to the amount of heat it gives out in burning.

Carcasses of sheep are thereby frozen to stony hardness immediately they are slaughtered in New Zealand and Australia, and then packed in close refrigerated cars, carried to the ship, and there stowed in chambers refrigerated by the same means, and thus brought to England in the same state of stony hardness as that originally produced. I dined to-day on one of the legs of a sheep that I bought a week ago and which was grazing at the antipodes three months before. I prefer it to any English mutton ordinarily obtainable.

The grounds of this preference will be understood when I explain that English farmers who manufacture mutton as a primary product kill their sheep as soon as they are full grown, when a year old or less. They can not afford to feed a sheep for two years longer merely to improve its flavor without adding to its weight. Country gentlemen who do not care for expense occasionally regale their friends on a haunch or saddle of three-year-old mutton, as a rare and costly luxury.

The antipodean graziers are wool-growers. Until lately, mutton was merely used as manure, and even now it is but a secondary product. The wool-crop improves year by year until the sheep is three or four years old; therefore, it is not slaughtered until this age is attained, and thus the sheep sent to England are similar to those of the country squire, and such as the English farmer could not send to market under eighteen pence per pound.

There is, however, one drawback; but I have tested it thoroughly, having supplied my own table during the last six months with no other mutton than that from New Zealand, and find it so trifling as to be imperceptible unless critically looked for. It is simply that, in thawing, a small quantity of the juice of the meat oozes out. This is more than compensated by the superior richness and fullness of flavor of the meat itself, which is much darker in color than young mutton. —*Knowledge.*

A DEFENSE OF MODERN THOUGHT.*

By WILLIAM D. LE SUEUR, B. A.

FROM the point of view of the present writer, there are good reasons for believing that a general readjustment of thought is now in progress, and that it is destined to go on until old forms of belief, inconsistent with a rational interpretation of the world, have been completely overthrown. This progressive readjustment is not a thing of yesterday; it is simply that gradual abandonment of the theological stand-point which has been taking place throughout the ages. As a modern philosopher has remarked, the very conception of *miracle* marks the beginnings of rationalism, seeing that it recognizes an established order of things, a certain "reign of law," with which only supernatural power can interfere. The progress beyond this point consists in an increasing perception of the universality of law, and an increasing disposition to be exacting as to the evidences of miracle. No candid person can read the history of modern times without arriving at the conclusion that the whole march of civilization illustrates, above everything else, this gradual change of intellectual stand-point. Man's power keeps pace ever with his knowledge of natural law and his recognition of the uniformity of its operations. What we see to-day is simply the anticipation by thousands of the conclusion to which all past discoveries and observations have been pointing, that the reign of law is and always has been absolute. This is really what "agnosticism," so called, means. It means that thinking men are tired of the inconsistencies of the old system of belief, and that they de-

* From a pamphlet reply to a lecture on "Agnosticism," delivered by the Lord Bishop of Ontario.

sire to rest in an order of conceptions not liable to disturbance. The great Faraday, who had not brought himself to this point, used to say that when he had to deal with questions of faith he left all scientific and other human reasonings at the door, and that when he had to deal with questions of science he discarded in like manner all theological modes of thought. The region of science was one region, that of faith was another; and between these he placed a wall so high that once on either side he could see nothing that lay on the other. He did not attempt to reconcile faith with science, as some do; he separated them utterly, feeling them apparently to be irreconcilable. Thus he virtually lived in two worlds—one in which no miracles took place, but in which everything flowed in an orderly manner from recognized antecedents, and another in which the chain of causation might be broken at any moment by supernatural power. Since Faraday's time, however, men of science have grown bolder. They have renounced the attempt to live a divided life. They do not believe in insuperable barriers between one field of thought and another. They believe in the unity of the human mind and in the unity of truth. They have made their choice—those of them at least whom the Bishop of Ontario designates as agnostics—in favor of a world in which cause and effect maintain constant relations. In doing so they do not act willfully, but simply yield to the irresistible weight of evidence. Miracle is a matter of more or less uncertain testimony, while the unchangeableness of natural law is a matter of daily observation. Miracles never happen in the laboratory. Supernatural apparitions do not haunt the museum. Distant ages and countries or lonely road-sides reap all the glory of these manifestations. What wonder, then, that the man of science prefers to trust in what his eyes daily see and his hands handle, rather than in narratives of perfervid devotees, or in traditions handed down from centuries whose leading characteristic was an omnivorous credulity? There is nothing negative in this attitude of mind. On the contrary, it is positive in the highest degree. The true man of science wants to know and believe as much as possible. He desires to know what *is* and to adapt his thoughts to that; and the universe is to him simply an inexhaustible treasure-house of truths, all of more or less practical import.

It is right, however, before proceeding further, to examine this word "agnosticism" a little, to see whether it is one that is really serviceable in the present controversy. That some have been willing to apply the term to themselves and to regard it as rather *ben trovato*, I am quite aware; but I think there are good reasons why serious thinkers should decline to call themselves by such a name, and should object to its application to them by others.

A question proposed for discussion either can or can not be settled; it either lies within or beyond the region in which verification is possible. If it lies within that region, no man should call himself an

agnostic in regard to it. He may withhold his judgment until the evidence is complete, but suspension of judgment is not agnosticism, which, if it means anything, means a profession of hopeless and, so to speak, invincible ignorance in regard to certain matters. But if it would be absurd for a man to profess himself an agnostic in regard to problems admitting or believed to admit of solution, is it not idle for any one to accept that designation because he believes that there are other problems or propositions which do not admit of solution? All one has to do in relation to the latter class of problems is to recognize their unreal or purely verbal character. It is the nature of the problem that requires to be characterized, not our mental relation thereto. The latter follows as a matter of course from the former. Moreover, why should any one wish or consent to be designated by a term purely negative in its meaning? It is what we know, not what we do not know, that should furnish us with a name, if it is necessary to have one. The little that a man knows is of vastly more consequence to him than all the untrodden continents of his ignorance. The chemist calls himself so because he professes to have a knowledge of chemistry: he does not invent for himself a name signifying his ignorance of political economy or metaphysics. Why, then, should any man adopt a name which defines his relation not to things that he knows or to questions to which he attributes a character of reality, but to things that he does not know and to questions which, so far as he can see, have no character of reality? Let others give him such a name if they will, but let no man voluntarily tie himself to a negation.

There are some, as I believe, who have adopted the appellation of agnostic thoughtlessly: some through indolence, as appearing to exempt them from the necessity of a decision in regard to certain difficult and, in a social sense, critical questions; and some possibly for the reason hinted at by the Bishop of Ontario, namely, lack of the courage necessary to take up a more decided position. Whatever the motive may be, however, I am persuaded that the term is a poor one for purposes of definition; and I should advise all earnest men, who think more of their beliefs than of their disbeliefs, to disown it so far as they themselves are concerned. If it be asked by what appellation those who do not believe in "revealed religion" are to be known, I should answer that it is not their duty to coin for themselves any sectarian title. They are in no sense a sect. They believe themselves to be on the high-road of natural truth. It is they who have cast aside all limited and partial views, and who are opening their minds to the full teaching of the universe. Let their opponents coin names if they will: they whom the truth has made free feel that their creed is too wide for limitation.

The Bishop of Ontario stands forth in the pamphlet before us simply as the champion of the two great doctrines of God and immortality. In reality, however, he is the champion of much more, for he

does not profess that these doctrines can stand by themselves apart from a belief in revelation. The issue between the bishop and those whom he styles agnostics is not really as to these two abstract doctrines, but as to the validity of the whole miraculous system of which his lordship is a responsible exponent. If we can imagine a person simply holding, as the result of his own individual reasonings or other mental experiences, a belief in God as a spiritual existence animating and presiding over the works of Nature, and a further belief in a future existence for the human soul, I do not see that there would necessarily be any conflict between him and the most advanced representatives of modern thought. No, the trouble does not begin here. The trouble arises when these beliefs are presented as part and parcel of a supernatural system miraculously revealed to mankind, and embracing details which bring it plainly into conflict with the known facts and laws of Nature. To detach these two doctrines, therefore, from the system to which they belong, and put them forward as if the whole stress of modern philosophical criticism was directed against them in particular, is a controversial artifice of a rather unfair kind.

We are reminded by the right reverend author that no chain is stronger than its weakest link, and we are asked to apply the principle to the doctrine of evolution, some of the links of which his lordship has tested and found unable to bear the proper strain. The principle is undoubtedly a sound one; but has it occurred to his lordship that it is no less applicable to the net-work of doctrine in which he believes than to the doctrine of evolution? Some links of that net-work are snapping every day under no greater strain than the simple exercise of common sense by ordinary men. It is a beautiful and well-chosen position that his lordship takes up as champion of the doctrines of God and immortality against "agnostic" science; but it would have argued greater courage had the banner been planted on the miraculous narratives of the Old and New Testament. A gallant defense of the scriptural account of the taking of Jericho, of the arresting for a somewhat sanguinary purpose of the earth's rotation, of the swallowing of Jonah by a whale, and his restoration to light and liberty after three days and nights of close and very disagreeable confinement, of the comfortable time enjoyed by Shadrach, Meshach, and Abednego in the fiery furnace, of the feeding of five thousand men with five loaves and two fishes and the gathering up of twelve basketfuls of the fragments—a gallant defense, I say, of these things would be very much more in order; for *these* are the links that criticism has attacked and which the common judgment of the nineteenth century is daily invalidating. Modern philosophy in its negative aspect is simply a revolt against the attempt to force such narratives as these upon the adult intelligence of mankind—against the absurdity of assigning to Hebrew legends of the most monstrous kind a character of credibility which would be scornfully refused to similar productions of the imagination

of any other race. Let there, then, be no misunderstanding: science is not concerned to prove that there is no God, nor even that a future life is an impossibility; it simply obeys an instinct of self-preservation in seeking to repel modes of thought and belief which, in their ultimate issues, are destructive of all science.

One has only to reflect for a moment, in order to see how much theological baggage the orthodox disputant throws away, when he confines his arguments to the two points of God and a future life. Were it thrown away in sincerity, argument might cease; but no, the manœuvre is first to make a formidable demonstration as champion of two cardinal doctrines which in themselves arouse little opposition, even where they do not commend assent, and then to apply the results of the proceeding to the benefit of those parts of the system which had been kept in the background. It is not in the interest of a simple theistic belief, unconnected with any scheme of theology, that the Bishop of Ontario writes: what he has at heart, I venture to say, is that men may believe as he does. The theism of Francis Newman, or of Victor Hugo, or Mazzini—all convinced theists—would be very unsatisfactory in his eyes, and it may be doubted whether he would take up his pen for the purpose of promoting theism of this type. It should, therefore, be thoroughly understood that, while his lordship is professedly combating agnosticism, he is really waging war on behalf of that elaborate theological system of which he is an exponent—that system which bids us look to the Bible for an account of the creation of the world and of man; and which requires us to believe that the Creator found it necessary in former times, for the right government of the world, to be continually breaking through the laws of physical succession which he himself had established. In arguing against the doctrine of evolution, he labors to establish the opposite doctrine of the creation and government of the world *by miracle*.

The question therefore is, Can science be free and yet accommodate itself to the whole elaborate scheme of Christian orthodoxy? The great majority of those who are most entitled to speak on behalf of science say No; and it is this negative which his lordship of Ontario converts into a denial of the two doctrines above-mentioned. But let those who are at all familiar with the course of modern thought ask themselves if they recall in the writings of any leading philosopher of the day arguments specially directed against the hypothesis of God, or even against that of a possible future state of existence for humanity. What every one can at once remember is, that the writers who are called "agnostics," the Spencers, Huxleys, Tyndalls, and Darwins, plead for the universality of Nature's laws and the abiding uniformity of her processes. That is what they are concerned to maintain, because it is upon that that all science depends. Scientific men in general are but little disposed to disturb any one's faith in God or immortality, so long as these doctrines are not associated with or put for-

ward as involving others which really invade the domain of science and tend to cast uncertainty upon its methods and results.

In seeking to account for "the modern spread of agnosticism," the bishop finds that it is to "the widely-spread popularity of the theory of evolution, leading as it does to materialism," that the phenomenon is to be attributed. Consequently the theory of evolution must be destroyed. The Episcopal edict has gone forth, and the Episcopal batteries are raised against this later Carthage of infidelity. But, alas! it does not sufficiently appear that the right reverend director of the siege understands either the nature of the task he has undertaken or the significance which would attach to success could he achieve it. To take the latter point first: science was making very rapid progress before the evolution theory had acquired any wide popularity, before in fact anything was known of it outside of one or two speculative treatises; and already the opposition of science to a scheme which makes this earth the theatre of miracle-working power was well marked. Twenty-two years ago, when "The Origin of Species" was but two years old, and had still a great deal of opposition to encounter even from men of science, before even the term evolution had any currency in the special sense it now bears, a leading prelate of the Church of England, Bishop Wilberforce, discerned a skeptical movement "too wide-spread and connecting itself with far too general conditions" to be explained otherwise than as "the first stealing over the sky of the lurid lights which shall be shed profusely around the great Antichrist."* To charge the present intellectual state of the world, therefore, on the doctrine of evolution is to ignore that general movement of thought which, before the idea of evolution was a factor of any importance in modern speculation, had already, as the Bishop of Oxford testified, carried thousands away from their old theological habitations, and which, with or without the theory of evolution, was quite adapted to produce the state of things which we see to-day in the intellectual world.

The doctrine of evolution is simply the form in which the dominant scientific thought of the day is cast. As a working hypothesis it presents very great advantages; and the thinkers of to-day would find it hard to dispense with the aid it affords. But supposing it could be shown that the doctrine, as at present conceived, was untenable—what then? Would men of science at once abandon their belief in the invariability of natural law and fly back to mediæval superstitions? By no means. If there is any class of men who have learned the lesson that the spider taught to Bruce, it is the class of scientific workers. Destroy one of their constructions and they set to work again, with unconquerable industry, to build another. In fact, they are always testing and trying their own constructions; and we may be sure that if the evolution theory is ever to be swept away it will

* *Vide* preface to "Replies to Essays and Reviews."

be by scientific not theological hands. It holds its ground now, because it is a help to thought and investigation; if it should ever become so beset with difficulties as to be no longer serviceable, it will be withdrawn from use, as many a theory has been before it, and as many a one will be in the days to come. Among contemporary men of science there is probably none who believes more strongly in the doctrine in question than the editor of "The Popular Science Monthly"; yet in a recent number of his magazine he has marked his attitude toward it in a manner which for our present purpose is very instructive. "It is undeniable," he writes, "that the difficulties in the way of the doctrine of evolution are many and formidable, and it will no doubt take a long time to clear them up; while the solution of still unresolved problems will very possibly result in important modifications of the theory as now entertained. But the establishment of the doctrine of evolution, as a comprehensive law of nature, is no longer dependent upon its freedom from embarrassments, or that absoluteness of proof which will only become possible with the future extension of knowledge. Notwithstanding these drawbacks, the evidence for it is so varied, so consistent, and so irresistible, as to compel its broad acceptance by men of science, who, while disagreeing upon many of its questions, find it indispensable as a guide to the most multifarious investigations."

We now come to the further question of the validity of the criticisms directed in the pamphlet before us against the doctrine of evolution, in discussing which the competency of the critic for his self-imposed task will necessarily come more or less under consideration. Let us first notice the quotations which his lordship brings forward, remembering that the doctrine of evolution in its present shape may be said to be the work of the last twenty years. Well, his lordship quotes three leading scientific authors—Owen, Agassiz, and Lyell; but it is noticeable that in no case does he give the date of his quotation, and in the case of the first two does not even mention the work in which the passage he refers to is to be found. The quotations are intended to show that these eminent authors rejected the doctrine of the "origin of species by natural selection." As regards Agassiz, who died ten years ago, every one knows that this was the case; and most are also aware that the great Swiss naturalist left behind him a son, a naturalist almost equally great, who supports the Darwinian theory as strongly as his father opposed it. Owen, though not a Darwinian in the full sense, held views which were clearly in the direction of natural selection. It is, however, when we come to Lyell that we have cause for astonishment. Here we have the most eminent of English geologists, whose adhesion to the Darwinian theory, announced for the first time in 1863—the date of the publication of the first edition of his "Antiquity of Man"—created such a sensation in the scientific world, quoted, at this time of day, as an anti-Darwinian! What are we to

think of this? I can not and do not believe, nor would I wish to suggest, that the Right Reverend the Bishop of Ontario was carried so far in his zeal against evolution as deliberately to misrepresent Sir Charles Lyell's attitude toward that doctrine. The only other hypothesis, however, is that of extreme ignorance. Of this his lordship must stand, not only accused, but convicted. The fact of Sir Charles Lyell's conversion to the views of Darwin on the origin of species was one of which the whole reading world took note at the time, and which has been known to every tyro in general science from that day to this. His lordship, quoting from the "Principles of Geology," but without any mention of edition, represents Sir Charles as holding "that species have a real existence in nature, and that each was endowed at the time of its creation with the attributes and organization by which it is now distinguished." That these *were* Sir Charles Lyell's views when the earlier editions of his "Principles" were published every one is aware; but it is a most extraordinary thing that any one should have quoted them as his full twenty years after he had distinctly abandoned them. The preface to the fourth edition of the "Antiquity of Man" opens as follows: "The first edition of the 'Antiquity of Man' was published in 1863, and was the first work in which I expressed my opinion of the prehistoric age of man, and also my belief in Mr. Darwin's theory of the 'Origin of Species' as the best explanation yet offered of the connection between man and those animals which have flourished successively on the earth." In the tenth edition of his "Principles," published in 1868, he says (page 492) that "Mr. Darwin, without absolutely proving this (theory), has made it appear in the highest degree probable, by an appeal to many distinct and independent classes of phenomena in natural history and geology." Darwin himself would not have claimed more for his theory than this. Professor Huxley would not claim more for it to-day. Enough for either of them the admission that, by arguments drawn from many quarters, it had been rendered "in the highest degree probable." In his "Antiquity of Man,"* Sir Charles Lyell expressly acknowledges the inconclusiveness of the arguments he had used at an earlier date to prove that "species were primordial creations and not derivative." His reasonings, he frankly confesses, could not hold their ground "in the light of the facts and arguments adduced by Darwin and Hooker." As regards the "descent of man," after quoting a passage from Darwin to the effect that "man is the co-descendant with other mammals of a common progenitor," he observes that "we certainly can not escape from such a conclusion without abandoning many of the weightiest arguments which have been urged in support of variation and natural selection considered as the subordinate causes by which new types have been gradually introduced into the world." On every point, therefore, the real views of Sir Charles Lyell, as formed in the

* See fourth edition, p. 469.

light of the facts adduced by Darwin and of his own maturer reasonings, were totally opposed to those quoted in the bishop's pamphlet. Is it not remarkable, such being the case, that not one member of the reverend and learned clergy of the diocese of Kingston, by whose special request this document was given to the world, should have suggested a correction on this point? Was there not a lay delegate who could have done it; or were they all—bishop, clergy, and laymen—equally in the dark? It would really seem so. Who can wonder that the doctrine of evolution does not make much progress in certain quarters?

Sir Charles Lyell unfortunately is not the only author misrepresented. Huxley is said to "discredit" the origin of life from non-living matter. Huxley does nothing of the kind; he simply says that the experiments heretofore made to show that life can be so developed have not been successful. On the page of the pamphlet immediately preceding that on which this statement is made in regard to Huxley, we are informed, correctly, that the same great naturalist professes "a philosophic faith in the probability of spontaneous generation." Surely his lordship could not have understood the force of these words, or he would not have said, almost immediately after, that "the origin of life on earth . . . is not only discredited * by Huxley but by many other great scientists." A writer who finds such comparatively simple language beyond his comprehension is not, one would judge, very well fitted to enter the lists against the leading thinkers of the day, except perhaps for strictly diocesan purposes.

That his lordship is really hopelessly at sea in discussing this question is evident by many signs. Such sentences as the following speak volumes for the mental confusion of their author: "Agnosticism takes refuge in evolution in order to get rid of the idea of God as unthinkable and unknowable." Here, again, inaccuracies of language. An idea may be unthinkable in the sense of not admitting of being *thought out*, but can an idea be said to be "unknowable"? What is an unknowable idea? An idea must be known in order to be an idea at all. But this mere verbal inaccuracy is not the worst. We had been told that agnosticism was a form of opinion according to which nothing could be known of God. Now, it seems that agnosticism has to fall back on evolution, "in order to get rid of the idea of God as unthinkable and unknowable." Now, the so-called agnosticism could not have been agnosticism in reality, otherwise it would not have required the help of evolution in such a matter. If we ask how evolution helps agnosticism to regard "the idea of God as unthinkable and unknowable," we shall only find the confusion growing worse confounded.

* His lordship means "discredited not only by Huxley, but by etc." The inaccuracy of expression observable here is paralleled in many other passages of the pamphlet. For example, his lordship says, page 5, "They are not content to speak for themselves, but for all the world besides." A bishop should write better English than this.

Evolution has nothing to do with such questions: it is a simple theory as to the mode of generation and order of succession of different forms of existences.

It is, however, when his lordship comes to discuss the doctrine of the survival of the fittest that his sad want of acquaintance with the whole subject shows itself most conspicuously. Let me quote: "By some means or other 'the survival of the fittest in the struggle for existence' is assumed to be a law of Nature, and if it be so our faith is severely taxed. Survival of the fittest—fittest for what? If the answer be, fittest for surviving, we argue in a circle, and get no information whatever. The only rational answer must be, they survive who are fittest for their environments in size, strength, and vigor." Let me here ask what sense the learned author can possibly attach to these last words execpt the very one he had just discarded as meaningless—"fitness to survive"? How is fitness to environment proved except by the actual fact of survival? Do environments always require "size" as an element of fitness? By no means, they sometimes require smallness. When a mouse escapes into a hole, where the cat can not follow, it survives not by reason of its size, but by reason of its smallness. Strength, again, is one element of adaptation to environment, but only one; and it may fall far below some other element, swiftness, for example, or cunning, in practical importance. The fact, however, that the learned author sees no meaning in the answer "fitness to survive," tells the whole story of his own unfitness for the special environment in which he has placed himself in attempting to discuss the doctrine of evolution, and rather tends to create doubt as to the survival of the work he has given to the world. This is a matter in which no aptitude in quoting Horace is of any avail. The road to an understanding of the terms and conceptions of modern science lies in a careful study at first hand of the works in which these terms and conceptions are expounded. His lordship assumes that, if we say that those survive who are fit to survive, we utter a barren truism. It is a truism we may grant, but not a barren one, any more than the axioms of geometry are barren. The simple word "fitness" implies a definite external something, adaptation to which is the price of existence. The definiteness of the mold involves the definiteness of that which is molded; and all the miracles of life and organization we see around us are in the last resort merely examples of adaptation to fixed conditions of existence. "Born into life we are," says Matthew Arnold, "and life must be our mold." By "life" understand the universe, and we have a poetical version of the doctrine of the survival of the fittest. It so happens, and this is a further truth which it would not be well to pass over, that adaptation does more or less imply excellence even from the human stand-point. All those adaptations that favor human life and happiness we of course call excellent, even though they may not be favorable to the life and happiness of other living creatures. And as

man has thriven mightily and prevailed, adaptation *in general* presents itself to him in a favorable light. Occasionally, when his crops are destroyed by some insect-pest wonderfully adapted for its work, or when his cattle are infested with deadly parasites, or when some germ of disease is multiplying a million-fold in his own frame, he sees that *all* adaptations are not yoked to his especial service.

His lordship seems to suppose that the believers in the doctrine of the survival of the fittest are bound to show that there has been a steady improvement of type from the first dawn of life. To show how gross and inexcusable a misunderstanding this is, I need only quote two sentences from Sir Charles Lyell's "Antiquity of Man": "One of the principal claims," observes the great geologist, "of Mr. Darwin's theory to acceptance is that *it enables us to dispense with a law of progression* as a necessary accompaniment of variation. It will account equally well for what is called degradation or a retrograde movement toward a simpler structure, and does not require Lamarck's continual creation of monads; for this was a necessary part of his system in order to explain how, after the progressive power had been at work for myriads of ages, there were as many beings of the simplest structure in existence as ever."*

Writing thus in ignorance of what the law of the survival of the fittest, as formulated by Darwin, and accepted by modern men of science, really means, his lordship is able to ask such pointless questions as whether the law is illustrated in the slaughtering of the flower of a nation in war, and whether it is the fittest who survive famines, pestilences, shipwrecks, etc. His lordship evidently does not himself believe there is any provision for the survival of the fittest in the providential government of the world; yet, strange to say, he taunts evolutionists with this lack in the general scheme of things. If it be an embarrassment to their theory, how much more should it be to the bishop's theology! The evolutionist might, however, turn round and instruct the divine out of his own pocket Bible, where it is expressly stated that the wicked shall not live out half his days; and then out of the newspapers which continually show us what happens to the violent and bloody man, to the intemperate, and to various other classes of evil-doers. The evolution philosophy does not guarantee, as has been already shown, continuous progress in what, from the human stand-point, may seem the best directions; but evolutionists are able to note, and do note with satisfaction, that the qualities which the moral sense of mankind most approves do in point of fact tend to the survival of their possessors. War itself illustrates the principle; seeing that the most important element of strength abroad is cohesion at home, a condition which must depend on a relatively high development of social justice. To take an example from our own history: English arms would not have been so successful as they have been

* Fourth edition, p. 459.

abroad, had there not been a united country behind them. It was the virtues, not the vices, of the Roman people that enabled them to conquer the world. It was their vices, not their virtues, that led to their fall. Fitness to survive is a quality the import of which varies according to circumstances. In shipwrecks (to pursue his lordship's illustrations) the fit to survive are those who can swim, or who have readiness of resource or strength of constitution. In famines and pestilences the physically stronger will as a rule survive; though here prudence and self-control become also most important elements of safety. Let it always be remembered that the problem with which evolutionary philosophy has to grapple is not how to account for a perfect world, or a perfect state of society, but how to account for just such a mingling of good and evil (accompanied by general tendencies toward good) as we actually witness. This once settled, most of the objections of the theologians would be seen to fall wide of the mark.

To persons unfamiliar, or but slightly familiar, with the present subject, it is possible that the Bishop of Ontario may appear to have touched a weak point in the doctrine under discussion where he says: "Laws of nature should be obeyed and co-operated with, not fought against and thwarted; and, if the survival of the fittest be one of those laws, we ought to abolish all hospitals and asylums for the blind, the deaf, the drunkard, the idiot, and the lunatic, and we ought to expose to death all sickly, puny, and superfluous infants." A word, therefore, in regard to this objection may not be thrown away. The first observation to make is, that there is nothing whatever in the law of the survival of the fittest, as understood by men of science to-day, which could possibly be converted into a rule of conduct. The scientific world is not aware that Nature has any ends in view, or is capable of having any ends in view, which she needs the help of man to enable her to realize. Science does not attribute purpose to Nature. Science has simply obtained a glimmering of how, in point of fact, Nature works. It sees that survival is a question of fitness, in other words a question of the fulfillment of the conditions on which continued existence depends. In some cases, as is well known, superiority of type becomes an impediment, not a help, to the preservation of life; and in a vast number of cases the differentiations on which survival depends imply neither progress nor retrogression.* What moral guidance, therefore, can possibly be found in a simple perception of the fact that in the realm of Nature there are conditions attached to survival? We may ask, in the next place, whether there is any single law of Nature which men "obey," or ever have obeyed, in the sense in which his lordship bids us obey the law of the survival of the fittest.

* *Vide* Spencer, "Principles of Sociology," vol. i, pp. 106, 107; and Haeckel, "History of Creation," vol. i, p. 285.

When a conflagration rages, do we "obey" and "co-operate" with Nature by adding fuel to the flames? When pestilence is abroad, do we try to increase its deadly activity? When we stumble, do we make a point of yielding to the law of gravitation and throwing ourselves headlong? When the winter winds are howling, do we throw open doors and windows that we may feel all the force and bitterness of the blast? Or do we, in these and all other cases, seek to modify the action of one law by that of another—a process his lordship calls "thwarting"—in order that their combined or balanced action may yield us, as nearly as possible, the results we desire? We throw water on the fire. We use disinfectants and prophylactics against the plague. We set muscular force against that of gravitation. We oppose warmth to cold. In none of these cases do we ask what Nature wants; we are content to know what *we* want. We don't really believe that Nature wants anything; so we have no hesitation or compunction in letting our wants rule. In the matter of the weak and sickly, they might perish if unconscious forces alone were at work, or even in certain conditions of human society; but it does not suit *our* interests, for very obvious reasons, to let them perish. To do so would strike at all human affections, and would so far weaken the bonds of society and render the whole social fabric less secure. Moreover, a sick man is very different from a sick animal. The latter is inevitably inferior as an animal, whereas the former may not only not be inferior, but may be superior as a *man*, and capable of rendering much service to society. Two instances occur to me as I write—that of the late Professor Cairnes, in England, and of the late Professor Ernest Bersot, in France, both smitten with cruel and hopeless maladies, but both fulfilling, in an eminent degree, the highest intellectual and moral offices of *men*. What the well do for the sick is of course obvious, and attracts sufficient attention; but what the sick do for the well, not being so obvious, attracts less attention than it deserves. Yet how many lessons of patience, fortitude, and resignation—lessons that all require—come to us from the sick-bed, or at least from those whom weakness of constitution or perhaps some unhappy accident has robbed of a normal activity and health! At times we see superiority of intellectual and moral endowment triumphing over the most serious physical disabilities; as in the case of the present Postmaster-General of England, who accidentally lost his sight when quite a youth. The late M. Louis Blanc, a man of splendid talents, never advanced beyond the stature of a child. The ancient Spartans might have exposed one of so feeble a frame on Taygetus; for with them every man had to be a soldier; but, in modern life, with its greatly diversified interests, many a man too weak to be a soldier can yet render splendid service to the community. It will, therefore, I trust, be sufficiently obvious, first, that Nature has no commands to give us in this matter; and, secondly, that there are excellent reasons why we should not treat the sick and

weakly, as the lower animals commonly, but not universally, treat the sick and weakly of their own kind.*

There is, however, another view of this question which should not be overlooked. While human beings in civilized countries manifest, and always have manifested, more or less sympathy with the physically afflicted, their steadfast aim has been to get rid of physical evil in all its forms. No care that is taken of the sick has for its object the perpetuation of sickness, but rather its extirpation. We do not put idiots to death; but when an idiot dies there is a general feeling of relief that so imperfect an existence has come to an end. Were idiots permitted to marry, the sense of decency of the whole community would be outraged. Public opinion blames those who marry knowing that there is some serious taint in their blood; and commends, on the other hand, those who abstain from, or defer, marriage on that account. There is probably room for a further development of sentiment in this direction. We need to feel more strongly that all maladies and ailments are in their nature preventable, inasmuch as they all flow from definite physical antecedents. As long as our views on this subject are tinged in the smallest degree with supernaturalism, so long will our efforts to track disease to its lair and breeding-grounds be but half-hearted. How can we venture to check abruptly, or at all, the course of a sickness sent expressly for our chastisement? Is it for us to say when the rod has been sufficiently applied? How do we dare to fortify ourselves in advance against disease, as if to prevent the Almighty from dealing with us according to our deserts? We vaccinate for small-pox, we drain for malaria, we cleanse and purify for cholera, we ventilate and disinfect, we diet and we exercise—and all for what? Precisely to avoid the paternal chastenings which we have been taught are so good for us, and the origin of which has always been attributed by faith to the Divine pleasure. Evidently our views are undergoing a change. We all wish to be fit to survive, and all more or less believe that it is in our power to be so and to help others to be so. We believe in sanitary science, and, if we attribute any purpose in the matter to the Divine mind, it is that all men should come to the knowledge of the truth, as revealed by a study of Nature, and live.

THE FACULTY OF SPEECH.†

By E. F. BRUSH, M. D.

UNTIL the beginning of this nineteenth century, the mind was considered as a unit. Early in the century, Gall, a distinguished German physician, noted the fact that those students whose super-

* See Romanes, "Animal Intelligence," pp. 471, 475, as to the sympathy exhibited by the monkey tribe toward their sick.

† Read at a meeting of the Mount Vernon Athenæum, January 24, 1883.

orbital plates were depressed sufficiently to produce protruding eyes and baggy under-lids excelled in memory, oratory, philology, and the ability to acquire languages. This observation may be called the foundation of phrenology, for it led Gall to divide the mind into faculties, and to locate the faculty of speech in the anterior lobes of the cerebral hemisphere. This was the basis of his system. But the enthusiasm with which he constructed this system, and the sweeping deductions which he and his follower, Spurzheim, drew from this one prominent fact, failed to interest the scientific mind. Soon after this, without paying any regard to the conclusions of Gall and Spurzheim, the pathologists discovered how frequently the loss of speech co-existed with diseases or injuries of the anterior lobes of the brain, and that sometimes the only symptom of cerebral lesions was a loss of the power of articulate language. These observations led Bouillaud, in 1825, to divide the faculty of speech into two phenomena, internal speech—the faculty to create and to represent ideas—and external speech, or the co-ordinating power necessary to articulate the words created. In medical literature, the loss of the faculty of speech is termed *aphasia*, and when it affects the internal speech it is designated as *amnesic* aphasia, and when external speech is affected the term *ataxic* aphasia expresses it.

But without going into detail respecting the weighty *pros* and *cons* in the discussion of this subject during the last fifty years up to the present time, it is safe to state that the power of speech is *twofold*, namely, *mental* and *motor*. Now, as a mental fact, the faculty of articulate language implies perception, intellectual distribution of perception, excitation of emotion, will to enunciate. As an illustration: we see a man across the street; we recognize him as John Jones, from Johnsonville; we experience pleasure, and say, "My dear friend, I am glad to see you." Thus it will be seen that the mind as regards speech can be divided into perception, intellect, emotion, and will. These are the mental attributes, and the impairment of any one of them will interfere with the culminating act of speech. The perception may be impaired, then the friend across the street would not start the mental train. Furthermore, if perception was perfect and the intellect impaired, we would see the man, perceive the color of his hair and eyes, the style of his clothing, and so forth, but not be conscious that we had met him before, and that he was a friend. Still further, if the emotion was impaired and the two other faculties normal, we would see the man, know he was a friend, but not be stimulated to further action. Again, if the three above faculties were normal and will-power wanting, we would see, recognize, and wish to speak to him, but be powerless to do so. All the best evidence of recent times indicates that these faculties reside in the gray matter which is spread over the surface of the cerebral hemispheres, with their manifold sulci and convolutions, and the depth of which is an index of the intellectual power,

rather than the mere mass of the brain, as was previously supposed. Now, this gray matter may be intact and, consequently, all the functions above enumerated may be perfect, and still the ability to articulate may be wanting, because the motor power which is supposed to reside in the white matter, and to preside over the co-ordinating power, controlling the nerves and muscles of articulation, may be impaired, and then, although our ideas may be correct, the ability to express them would be wanting. Medical literature abounds with cases which illustrate this condition. I select the following instance as a perfect illustration of this state: An intelligent man, sixty years old, suddenly became incoherent and quite unintelligible to those around him. He had forgotten the names of every object in nature; his recollection of things seemed to be unimpaired, but the words by which men and things were designated were entirely obliterated from his mind, or rather he had lost the faculty by which they were called up at the control of will. He was, however, by no means inattentive to what was going on, and he recognized friends and acquaintances quickly, but their names, or even his own, or his wife's name, or the names of any of his domestics appeared to have no place in his recollection. One morning, much against the wishes of his family, he went to his workshop, and, when visited by his physician, gave him to understand by a variety of signs that he was perfectly well in every respect, with the exception of some slight sensations referable to the eyes and eyebrows. He was so well in bodily health that he could not be confined to the house, and his judgment, so far as an estimate could be formed of it, was unimpaired, but his memory of words was so much a blank that the monosyllables of affirmation and negation were the only two words of the language the use and signification of which he never entirely forgot. He comprehended perfectly every word that was spoken or addressed to him, and, although he had ideas adequate to form a full reply, the words by which these ideas are expressed seemed entirely obliterated from his mind. By way of experiment, the name of a person or thing was mentioned to him, his own name for example, or that of one of his domestics; he would repeat it once or twice distinctly, but generally before he could do so a third time the word was gone from him as completely as though he had never heard it pronounced. When any one read to him from a book he had no difficulty in perceiving the meaning of the passage, but he could not himself then read. He had forgotten the elements of written language. He became very expert in the use of signs, and his convalescence was marked by his imperceptibly acquiring some general terms which were with him at first of very extensive and varied application. All future events and objects before him were, as he expressed it, "next time"; but past events and objects behind him were designated "last time." One day being asked his age, he pointed to his wife and uttered the words "Many times" repeatedly, as if he meant that he had often

told her his age. When she said "Sixty," he answered in the affirmative. Some months afterward he suddenly became paralyzed on the right side, and a few months later died from an attack of apoplexy. His brain was found extensively diseased in the white portion of the anterior lobe of the left hemisphere.

This case was purely and simply an impairment of external speech. On looking over the medical literature on the subject I have been unable to find as striking a case of impairment of internal speech, and this fact can be readily understood when we consider that a lesion necessary to produce this condition would be a destruction of the gray or cortical matter of the brain, and when this is injured the whole intellect becomes disjointed, as we see in the maniac, where the simple mechanical power of speech is perfect, but the incoherency and the wrong interpretation of external impressions are evident. I have said that these cases of the derangement of the faculties of internal speech are chiefly found in lunatic asylums. But, when I think, I remember to have met many mild cases outside of asylums, cases which can be best described by our Americanism of "talking too much with their mouth."

I have said the faculty of speech resides in the anterior lobes of the brain. But the evidence gleaned from pathology is convincing that the faculty is confined to a comparatively limited portion of the frontal lobe of the left cerebral hemisphere. This localization of a function to a single side of the brain is a curiously interesting fact. But when it is known that the left side of the brain presides over the motions and sensations of the right side of the body, it may be conceived that because we are right-handed we are left-minded. Why we are right-handed involves a discussion which would be beyond the limits of the present essay. But that the left side of the brain is almost always larger than the right is a well-known fact, and this asymmetry of the encephalon was prominently brought before the public during the Guiteau trial, with its prominent, ghastly rhombo-cephalic.

A curiously complicated and wonderful adaptation is this faculty of speech, sometimes bearing weighty loads of truth, at other times the veriest dregs of gorged society—words, windy words. The highest and best result of education is to form our ideas into words, to crystallize them into speech. We all feel that here we fail. Our thoughts well up and almost burst their limits, but faulty speech will not give the color and glow which the soul infuses into the thoughts. We can all say with the poet:

> "Our whitest pearls we never find,
> Our ripest fruit we never reach;
> The flowering moments of the mind
> Drop half their petals in our speech."

BIBLICAL AND MODERN LEPROSY.

By GEORGE HENRY FOX, M.D.,

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THE diseases which prevailed among the children of Israel were doubtless as numerous and as varied as those which now exist, and to a great extent they were probably identical with those affecting humanity at the present time. The most notable one spoken of in the Old Testament is called *leprosy*. As there exists at the present day a disease called by the same name, a consideration and comparison of the two may prove of interest.

The leprosy of the present day is found not only in distant parts of the world, but also in our own country. In Egypt, where it doubtless originated, and has prevailed for several thousand years, it still occurs. In Syria, India, China, and Japan, it is quite common. In Europe it is endemic chiefly along the shores of the Mediterranean and in Norway, although occasional cases are met with from time to time in many of the larger cities. In the West Indies and portions of South America it is also common, and in the Sandwich Islands it has increased rapidly in recent years, and now afflicts a large proportion of the native population. Coming nearer home, we find the disease existing among the Chinese in California, among the Norwegians in Minnesota, among the French and negroes in Louisiana, and among certain French Canadians in New Brunswick and Nova Scotia. During the past ten or fifteen years there have constantly been from one to a half-dozen or more cases in the hospitals of New York city. while other cases have been reported from Boston, Philadelphia, Baltimore, and other cities. Most of these cases have occurred among sailors or others, who have spent considerable time in the tropics or in regions where leprosy is common, and there contracted the disease. In New York there has occurred but one case in a person who had not been outside of the State, and in this case the origin of the disease could not be explained. It is an extremely difficult matter to determine beyond all doubt whether leprosy spreads only through hereditary transmission, or only through direct contagion, or in both ways. The disease is considered, by many who have had the best opportunities for studying it, to be hereditary in some cases, and at the same time capable of being propagated through inoculation. When leprosy once becomes prevalent in a community where vice, ignorance, and filth abound, it usually tends to increase, but it is far from being a highly contagious disease, as is commonly imagined. Physicians and hospital nurses have no hesitancy in caring for leprous patients, and the fear of the disease spreading through an intelligent community is

based mainly upon sensational reports which have appeared from time to time in the newspapers.

I will not enter upon a detailed description of this dread malady. It is one which profoundly affects the constitution of its victim, and usually terminates fatally in from five to fifteen years. It can not be said to be an absolutely incurable disease, although the most that medical skill has succeeded in accomplishing, save in a few exceptional instances, has been to cause a temporary disappearance of the symptoms at the outset, or to mitigate the suffering of the patient in the later stages. In some cases, the disease appears in the form of dull, brownish spots upon the skin, with loss of its natural sensibility. This is the *macular* form of leprosy. In other cases the disease is characterized by the formation of dark, reddish-brown lumps upon the face and other parts of the body, which give the leper a peculiarly unsightly expression. This constitutes the more severe or *tubercular* form of the disease. In all cases the nerve-trunks are more or less affected, and the sense of touch in the extremities is greatly impaired. The hands shrivel, the fingers become bent like claws, ulceration takes place in some cases, and the joints drop off one by one. The leper now becomes an utterly helpless and pitiable object.

Such is leprosy as met with at the present day, and at once the interesting question arises, "Is this the leprosy of olden time—the *tsaraath* of the Old Testament?" Without doubt the disease of which I have been speaking existed among the Egyptians and the Israelites in Moses's day, and from Egypt gradually made its way along the coasts of the Mediterranean to Greece and later to Italy. There is doubt, however, as to whether Moses was perfectly familiar with the leprosy which we now recognize, and distinguished it from other affections of a severe and contagious character. Certainly there are no scriptural references to any disease which is unmistakably the leprosy of the present day. We read that when Moses put his hand into his bosom and took it out again at the command of the Lord, "Behold his hand was leprous as snow." When the anger of the Lord was kindled against the sister of Moses, "Behold, Miriam became leprous, white as snow." Again, Gehazi, the servant of Elisha, was told by the prophet: "The leprosy, therefore, of Naaman shall cleave unto thee and unto thy seed forever. And he went out from his presence a leper as white as snow." Now, there are certain affections of the skin, met with at the present day, to which the expression "white as snow" would be applicable, but leprosy is not one of them. Indeed, in this disease, the skin usually becomes dark rather than light in color, and in none of the few score of cases which I have had the opportunity of observing would the phrase "white as snow" be other than highly inappropriate.

The somewhat detailed description of leprosy which is found in the thirteenth chapter of Leviticus is almost unintelligible in the light of

our present knowledge, and, after making due allowance for the necessarily imperfect translation of the Hebrew scriptures, we are forced to believe that Moses associated leprosy with other diseases, as many distinguished medical writers have done in later years. Indeed, it is only during the past few decades that the disease has been carefully studied in various parts of the world and its identity thoroughly established.

In studying the Mosaic laws respecting leprosy, we find statements made and directions given for its recognition by the priests who could not have referred to the disease which we now call leprosy. For instance, it is stated that if the leprosy cover the whole skin of him that hath the plague, the priest shall pronounce him clean. This would hardly apply to modern leprosy, which never involves the whole skin, as far as my observation goes. But there are other cutaneous affections which frequently do cover the afflicted subject "from his head even to his foot." Why the leper should have been pronounced unclean while the disease was spreading, and clean when it had reached that point where further spreading was impossible, I will leave for others to determine, merely remarking that a law which permitted only such lepers within the camp as were covered by the disease from head to foot could certainly not have had a sanitary origin. Furthermore, the rule that the leper should be shut up for seven days, and then examined by the priest, with a view to noting the change that had taken place in the mean time, would seem to indicate some other disease than modern leprosy, for the latter is extremely chronic in its course, and never presents any noticeable change in so short a time even under the most active treatment. What was meant by the reference to leprosy of clothing and of houses is now difficult to understand. There are infectious diseases at the present day, the germs of which may dwell for a time in clothing and the walls of houses, but there is nothing in connection with the modern leprosy which would justify us in believing that it ever infects an inanimate object.

On the other hand, if we assume that the leprosy of ancient times was identical with that of the present day, it seems strange that Moses failed to mention the loss of sensation, the deformity of the hands, and other features which are the most striking characteristics of the disease. That the leprosy which I have described has not changed its type in the course of centuries, as other diseases have done in a comparatively short time, is shown by the fact that some of the earliest medical descriptions are so correct that they might answer their purpose in a modern text-book, and we are therefore led to the conclusion that Moses, though possessing all the learning of the Egyptian priests, including the highest medical knowledge of his age, did not note the distinctive characteristics of leprosy, but classed it under one name with other prevalent diseases.

In this connection, it may be of interest to consider very briefly the character of the disease mentioned as leprosy in the New Testa-

ment. However uncertain we may be as to the precise nature of the Mosaic disease, it appears to me to be almost certain that the leprosy cured by our Saviour, after his sermon on the mount, was not the leprosy of the present day, but a far more common disease which is now known as *psoriasis*. The earliest Greek writers on medicine were unacquainted with Egyptian leprosy, except by hearsay. Hippocrates, writing over four hundred years before Christ, speaks of it as "the Phœnician disease," and even at the time of the Septuagint translation of the Pentateuch this leprosy was practically unknown to the Greeks. The Hebrew word *tsaraath* was translated by the Greek word *lepra*, which was the name of a disease characterized by white scaly patches upon the skin. This differed totally in its nature from the disease which is now called leprosy, and which prevailed at that time in Egypt and Palestine. This disease, being subsequently introduced into Greece, was designated by a different name, *elephantiasis*. At the time when the Gospels were written, the Greek medical writers recognized two distinct diseases under these names, *lepra* and *elephantiasis*. The former was the psoriasis, or white, scaly disease of the present day; the latter was the modern leprosy. The description of each of these diseases by Greek writers is explicit and readily recognizable, and the Gospels of Matthew and Mark agree in the statement that it was lepra and not elephantiasis which was cured by our Saviour. In other words, it was psoriasis, and not the modern leprosy.

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

MISCELLANEOUS REMEDIES.

ANÆSTHETICS. — The inductive study of Nature has often proved the shortest way to discoveries which other methods can reach only by a circuitous route. The ancient Greeks, recognizing the significance of the fact that malarial complaints vanish at the approach of winter, cured their fever-patients by refrigeration, and this century of research will perhaps close before some experimenting Pasteur stumbles upon the fact that the proximate cause of ague and yellow fever can be traced to the agency of microscopic parasites whose development may be arrested by the influence of a low temperature. More than two thousand years ago the movement-cure, the fasting-cure, and other reactions against the baneful tendencies of the drug-delusion, were anticipated by the school of the natural philosopher Asclepiades.

The principle of the best *natural anæsthetic*, too, was practically applied, if not theoretically understood, by our rude ancestors. No one who has watched the contest of a pair of rough-and-tumble fighters—

biped or quadruped—or participated in a scuffle of that sort, can doubt that the excitement of the fight temporarily blunts the feeling of pain. Count Ranzau, the "Streit-Hans"—"Rowdy Jack," as his comrades used to call him—once received three dagger-stabs before he knew that he was wounded at all. Soldiers, storming a battery, have often suddenly broken down from the effects of wounds which they had either not felt, or suspected only from a growing feeling of exhaustion. Olaf Rygh, the Norwegian Herodotus, tells us that, when the old Baresarks felt the approach of their end, they robbed death of its sting by drifting out to sea in a scuttled or burning boat, and thus expired, "screaming the wild battle-songs of their tribe." The Roman gladiators shouted and laughed aloud while their wounds were being dressed. A scalded child sobs and gasps for a therapeutical purpose: instinct teaches it the readiest way to benumb the feeling of pain. The physiological *rationale* of all this is that *rapid breathing is an anæsthetic.* In a paper read before the Philadelphia Medical Society, May 12, 1880, Dr. W. A. Bonwill ascribes that effect to the influence of the surplus of oxygen which is thus forced upon the lungs, just as by the inhalation of nitrous-oxide gas (which is composed of the same elements as common air, but with a larger proportion of oxygen), and mentions a large variety of cases in his own practice where rapid breathing produced all the essential effects of a chemical pain-obtunder, without appreciably diminishing the *consciousness* of the patient. Persons who object to the use of chloroform (perhaps from an instinctive dread that in their case the ether-slumber might prove a sleep that knows no waking), can benumb their nerves during the progress of a surgical operation by *gasping as deeply and as rapidly as possible.* "One of the most marked proofs of its efficacy," says Dr. Bonwill, "was the case of a boy of eleven years of age for whom I had to extract the upper and lower first permanent molars on both sides. He breathed rapidly for nearly a minute, when I removed in about twenty seconds all four of the teeth. He declared there was no pain, and we needed no such assertion, for there was not the slightest indication that he was undergoing a severe operation."

The administration of chloroform often produces distressing after-effects, nausea and sick-headaches, that sometimes continue for days together; and I remember two instances in the records of a French military hospital where it resulted fatally in the case of patients who had in vain protested and offered to forego the benefits of the anæsthetic—perhaps actually from an instinctive consciousness of some constitutional peculiarity which in their case increased the risks of its use. Ether-spray, on the other hand, is a legitimate application of the principle that *cold benumbs the feeling of pain.* Death by freezing is preceded by an absolute anæsthesia; and the painfulness of bruises, wasp-stings, etc., can be diminished by the topical application of an ice-poultice.

APOPLEXY.—The proximate cause of apoplexy is due to a congestion of the cerebral blood-vessels, induced by alcoholism, dietetic excesses, combined with the influence of sedentary habits. Consciousness, at least, can generally be restored by lessening the tendency of the circulation toward the head. The patient should be propped up in a sitting posture, with his head erect, his neck bared, and his temples and occiput moistened with cold water, while friction or a warm foot-bath should determine the circulation toward the extremities. Open every window of the sick-room, and, after the patient has sufficiently recovered to sit up in his bed, direct him to turn his face toward the cool draught, and now and then cool his temples with a cataplasm of crushed ice. For the first twenty-four hours let him abstain from all solid food.

Persons with an apoplectic diathesis should adopt a frugal and aperient diet, and avoid prolonged sedentary occupations, especially in a heated room. They should also avoid superfluous bedclothing, and open their bedroom-windows in all but the stormiest nights. The feet, however, ought to be kept warm under all circumstances. Plethoric gourmands ought at least to renounce late suppers and alcoholic stimulants.

BURNS AND SCALDS.—Loose cotton, slightly moistened with linseed-oil, has an almost magical effect in relieving the pain of severe burns. When inflammation has supervened, the feverish condition of the patient requires cooling ablutions and the free use of ice-water, both topically and as a sedative beverage. Slight burns can be treated with any emollient application, and a piece of common court-plaster is sufficient to protect the sore till a new skin has formed under the blister.

CHILBLAINS. — The effect of frost-bites is often aggravated by a too sudden change of temperature, or rather by the application of the wrong kind of caloric. The restoring warmth should come from within rather than from without. It is not necessary to scrape a frost-bitten person with icicles, after the Russian plan ; friction of any kind above or around the affected part will restore, as far as possible, the suspended circulation of the blood, and thus initiate the remedial functions of Nature. Deep foot-sores should be bandaged with linen rags and clean, warm tallow.

DROPSY.—It is a suggestive fact that the prevalence of dropsy has decreased since bleeding has gone out of fashion. There was a time when venesection was resorted to in nine out of ten kinds of diseases, and at that time a complaint which in its chronic form appears now almost only as a consequence of outrageous dietetic abuses was nearly as frequent as consumption. Bleeding impoverishes the blood, and dropsy, in any of its forms, can nearly always be traced to a depravation of the humors by unwholesome food or drink, or a disorder of the blood-making organs. As a symptomatic complaint, for in-

stance, dropsy frequently appears in the last stage of pulmonary consumption, when the wasted lungs have become unable to fulfill the chief purpose of respiration. Next to the alcohol-habit, the habitual breathing of impure air is the present main cause of dropsy, for air is gaseous food, and a sufficient supply of oxygen a chief preliminary in the conditions of the blood-making process. Malarial diseases likewise impoverish the blood by a direct process of disintegration;* and dropsy appears as an occasional after-effect of a long-continued ague. Remedies: Mountain-air, a light but nourishing diet, and strict abstinence from alcoholic stimulants.

EMETICS.—Tepid water is a prompt, and the most harmless, emetic. In urgent cases (poisonings, etc.) add a modicum of white mustard (*Sinapis alba*), and tickle the fauces with the wing-feather of a pigeon, or any similar object. Excessive vomiting can be checked by stimulating applications to the pit of the stomach and the extremities.

EPILEPSY.—Epilepsy, or the falling-sickness, is a complication of nervous derangements,† and results more frequently from sexual excesses than from all other causes combined. In young children, however, epilepsy is sometimes a consequence of teething-difficulties, of acidity in the stomach, and of worms, and in such cases can be readily cured by a change of regimen,‡ or, in malignant cases, by a protracted fast. For adults, strict continence and out-door exercise is the best prophylactic. Excessive heat, however, should be carefully guarded against, as well as all exciting passions.

EXCORIATION.—Infants are apt to become "galled" in particular parts of their bodies, about the groins, the lower part of the neck, and under the arms—especially in consequence of the condemnable practice of tight swaddling. To dry up such sores, "galling-plasters" (acetate of lead, etc.) often lead to worse complications, and the best remedy is cleanliness, and fine lint, smeared with spermaceti-ointment or warm tallow.

FAINTING-FITS, OR SYNCOPE.—Syncope, or "fainting," "*Ohnmacht*," "*Desmayo*," as three nations have called it with a correct appreciation of its chief cause, as distinct from that of apoplexy and convulsions, results from a general deficiency of vital strength. Cold water, applied to the neck, the feet, and the palms of the hands, by means of a bathing-brush, is the best restorative. In severe cases inflation of the lungs by mechanical means has often proved effective. Dr. Engleman mentions the case of a lady in child-bed, who, "after being happily delivered, suddenly fainted and lay upward of a quarter of an hour apparently dead. A physician had been sent for; her own maid, in the mean while, being out of patience at his delay, attempted to assist her herself, and, extending herself upon her mistress, applied

* "Climatic Fevers," "Popular Science Monthly," vol. xxiii, p. 477.
† "Nervous Maladies," "Popular Science Monthly," vol. xxiv, p. 454.
‡ "Enteric Disorders," "Popular Science Monthly," vol. xxiv, p. 196.

her mouth to hers, blew in as much breath as she possibly could, and in a very short time the exhausted lady awakened as out of a deep slumber, when, proper things being given her, she soon recovered. The maid being asked how she came to think of this expedient, said she had once seen it practiced by a midwife with the happiest effect."

A little stream of water falling from a height on the face and neck, the irritation of the olfactory nerves by means of snuff or pungent smells (burned pepper, etc.), the motion of a rumbling cart, have now and then sufficed to restore suspended animation. Persons subject to fainting-fits can use no better prophylactic than gymnastics in winter, and cold baths and pedestrian excursions in summer-time.

Febrile Affections.—In all disorders of a malarial and typhoid character, as well as in scarlet fever, measles, small-pox, and epidemic erysipelas, *refrigeration** is more efficacious than any medicine. In several zymotic diseases, besides cholera and yellow fever, the action of antiseptic drugs is annulled by the inversion of the digestive process: the chyle is forced back upon the stomach, and, mingled with the red corpuscles of the disintegrated blood, is voided in that discharge of *cruor* known as the black-vomit. Bleeding, instead of reducing the virulence of the fever, is apt to exhaust the little remaining strength of the patient. Lord Byron, for instance, was bled to death as surely as if the surgeon had cut his throat.

Gout.—A paroxysm of this dread penalty of idleness and intemperance is preceded by certain characteristic symptoms—lassitude, eructations, a dull headache, involuntary tears, a shivering sensation about the groins and thighs. If the lassitude has not yet taken the form of an unconquerable lethargy, the patient may obviate the crisis of his affection by severe and unremitting physical exercise, a prophylactic which, though doubly grievous in a debilitated condition, is incomparably preferable to the hellish alternative. I knew an old army officer who kept a spade in his bedroom, and, at the slightest premonitory symptoms, fell to work upon a sandy hill-side, and once dug a deep trench of forty-five feet in a single night, and toward morning staggered to his quarters and had barely time to reach his bed before he sank down in a *deliquium* of exhaustion, and awakened late in the afternoon as from a fainting-fit, with sore knees and sorer hands, but without a trace of the gout from which his compact with the powers of darkness proved to have respited him for a full month. The racking pain can be somewhat relieved by such counter-irritants as blisters, violent friction with hot flannel, etc., or actual cautery and the topical application of opiates. The experiments of sixteen carnivorous and alcohol-drinking nations have revealed dozens of similar palliatives, but only two radical remedies—frugality and persistent exercise.

Headache.—Chronic headache is generally a symptom of disordered digestion. To attempt the suppression of the effect while the

* "Climatic Fevers," "Popular Science Monthly," vol. xxiii, p. 477.

cause remains can bring only temporary relief, or even increases the subsequent malignity of the disorder. Strong black tea may thus act as a charm—for a day or so; but with the next morning the trouble not only returns, but returns aggravated by the supposed remedy, for chronic headache has no more potent single cause than the habitual use of narcotic drinks. A frugal, non-stimulating regimen, on the other hand, brings help more slowly but permanently, unless the patient abuses the restored vigor of his digestive organs. Acute headaches can generally be traced to influences which tend to obstruct the free circulation of the blood—tight clothing, coldness of the extremities, oppressive atmospheric conditions, etc.—and can be cured only by a direct removal of the cause. As a symptomatic result of a vitiated state of the humors, as in scrofula and venereal diseases, headaches that defy all medicine often yield to a grape-cure.*

Heart-burn, or Cardialgia.—Both words are misnomers, the seat of the pain being the pit of the stomach, and the cause gastric acidity; remedies—fasting and "passive exercise," a ride in a jolting cart, kneading of the abdomen, etc.

Hypochondria, Chronic Melancholy, Spleen.—Robert Burton, in his "Anatomy of Melancholy," enumerates some six thousand causes of chronic despondency, and about as many different remedies, of which only six or seven are apt to afford permanent relief: frugality, temperance, early rising, life with a rational object (altruistic, if egotism palls), constructive exercise in the open air, a sunny climate, and social sunshine—the company of children and optimists.

Insomnia.—The proximate cause of sleeplessness is plethora of the cerebral blood-vessels, and a palliative cure can be effected by anything that lessens the tendency of the circulation toward the head. But a permanent cure may require time and patience. By night-studies brain-workers sometimes contract chronic insomnia in that worst form which finds relief only in the stupor of a low fever, alternating with consecutive days of nervous headaches. Reforming topers often have to pass through the same ordeal, before the deranged nervous system can be restored to its normal condition. Fresh air, especially of a low temperature, pedestrian exercise, and an aperient diet, are the best natural remedies. Under no circumstances should sleeplessness be overcome by narcotics. An opium torpor can not fulfill the functions of refreshing sleep; we might as well benumb the patient by a whack on the skull.

Jaundice.—Jaundice and chlorosis are kindred affections, and the yellow tinge of the skin is often in both cases due to an impoverished state of the blood—especially a deficiency in the proportion of the red blood-corpuscles—rather than to a diffusion of bilious secretions. Jaundice, as a consequence of obstinate agues, is evidently the result of a catalytic process which disintegrates the constituent parts

* "Enteric Disorders," "Popular Science Monthly," vol. xxiv, p. 457.

of the blood. The bite of poisonous animals has often a similar effect. The most frequent predisposing cause, however, is want of sunlight and out-door exercise. Jaundice and chronic melancholy are often concomitant affections, and both a penalty of our dreary, sedentary modes of life. The ancients, indeed, ascribed both complaints to the same cause, for *melancholy* is derived from a word which means literally "atrabilious," or black-biled. But the truth seems to be that functional disorders of the liver are the result rather than the cause of a general torpor of the vital process. Remedy—outdoor sports, combined with as much fun and sunshine as possible. Alcoholic jaundice-cures may restore the ruddiness of the complexion by keeping the system under the influence of a stimulant fever; but we might as well congratulate ourselves on the return of health when pulmonary affections mimic its color with their hectic glow.

MENTAL DISORDERS.—The *Lalita Vistara* says that on the day when Buddha, the savior, was born, all the sick regained their health and the insane *their memory*. Insanity might, indeed, be defined as a partial derangement or suspension of the faculty of recollection. Nature takes that method of obliterating the memory of impressions which the soul is unable to bear, and thus preserves life at the expense of its intellectual continuity. Lunatics are generally *monomaniacs;* their judgment may be sound in many respects, but, at the mention of a special topic, betrays the partial eclipse of its light. It may be possible that people have been killed by the sudden announcement of good news, but, for one person who has lost his reason from an excess of joy, millions have lost it from an excess of sorrow—a crushing calamity, or the oppressive and at last unbearable weight of the dreariness, the soul-stifling tedium of modern life in many of its phases. The sick soul may have stilled its hunger with a long-hoarded hope, till the evident exhaustion of that hoard leaves only the alternative of despair or refuge in the Lethe of dementation. Where insanity is at all curable it can be cured by the removal of its chief cause—sorrow; and the best remedies are kindness, mirth, and a pleasant occupation. In the middle ages, when both lunacy and the love of earthly happiness were ascribed to the machinations of the devil, lunatics were chained and horsewhipped for the double benefit of their souls, and with results which almost justified the demon hypothesis. Breughel's best illustrations for Dante's hell were made after studies in an Austrian mad-house. The extreme antithesis of such *infernos* is perhaps the State Lunatic Asylum at Tuscaloosa, Alabama, where the shadow of gloom has been so successfully banished that the happiest results of the cure have almost been anticipated by its methods: the restoration of reason itself could hardly give the patients an additional reason for being happy. They have a park, a flower-garden, and a pet nursery of their own; they have books and music, gymnasia, bath-rooms, and amateur workshops. Wherever their road leads, they can

travel it in sunshine, even on hobby-back if they choose, for they have a philosophical weekly of their own, with full permission to explain the revelation of St. John.

Myopia—short-sightedness, and far-sightedness (presbyopia), were formerly regarded as absolutely incurable affections, because they were evidently not amenable to the influence of any known drug. But "drug" and "remedy" have at last ceased to be synonymous terms; and, though constitutional defects of the eye may preclude the possibility of a complete cure, there is no doubt that those defects can be modified by a judicious treatment, especially by a mode of life tending to restore the general vigor of the system, by out-door exercise, and by rambles in green, sunny woods, for the colors of the summer forest are as beneficial to the eye as its atmosphere to the lungs. Weak eyes can be strengthened by gradually exercising the capacity of the optic nerve, scrutinizing small objects, first at a moderate and by-and-by at a greater distance, but withal guarding against a fatiguing effort of the eye.

Pimples.—The best cosmetic is a grape-cure, i. e., a frugal, saccharine, and sub-acid diet, combined with out-door exercise in the bracing air of a highland country.

Rheumatism.—Rheumatism, like gout, is a consequence of dietetic abuses. Counter-irritants, hot baths, etc., can effect a brief respite, but the only permanent specific is fasting. Before the end of the second day a hunger-cure benumbs the pain; the organism, on being obliged to feed upon its own tissues, seems to undergo a process of renovation which alone can reach the root of the complaint. Exercise and great abstemiousness will prevent a relapse.

Scrofula.—A scrofulous taint is in some cases hereditary, and yields only to years of dietetic reform, but, on the whole, there is no more perfectly curable disease. In all but its most malignant forms it yields readily to the influence of pure air and pure food—out-door life, and a wholesome, vegetable diet. Skin-cleaning nostrums only change the form of the disease by driving it from the surface to the interior of the body.

Toothache.—The extraction of every unsound tooth and the insertion of a "new set" would certainly remove, *in ipsa radice*, the seat, if not the cause, of the evil. But the trouble is, that the function of proper mastication is an indispensable preliminary of digestion, and that for practical efficacy the last stump of a natural tooth is infinitely preferable to the best artificial substitute. The best plan would, therefore, be to let the stumps remain, and get rid of the pain, and the latter end can be attained by a slow but infallible method. Within half a year after the change of regimen, *absolute abstinence from hot drinks* (especially boiling hot, sweet tea) and a *very sparing use of animal food* will benumb the sensitiveness of the irritated nerves. I knew an old Mestizo who had learned to chew apples

with his bare gums, but only after necessity had reduced him to a frugal regimen. A saccharine diet in the form of sweet ripe fruit has certainly nothing to do with the decay of the teeth, and it is a suggestive fact that toothache is almost exclusively an affliction of the northern nations.

WARTS AND CORNS.—The predisposing cause of warts is unknown, and the popular remedies are rarely permanent. I have known warts to reappear after they had been thoroughly removed by the use of corrosive acids. The popular belief that they "spread" if the operation involves bleeding seems not to be wholly unfounded, and large warts can be more effectually cured by means of a tight ligature that gradually deadens the tissue. Warts on the upper side of the fingers can generally be atrophied by exerting a long-continued strain upon the adjoining muscles, as in holding up a heavy weight, or seizing the rings of a grapple-swing and dangling by one hand as long as the fingers can support the strain. A callous skin is thus formed under the wart, and before long the excrescence disappears. Corns are entirely owing to the pressure of tight shoes, and can be cured by the use of more commodious foot-wear. To suppress the symptom, while the cause remains, is of little avail, and, before a chiropodist could keep his promise to "remove corns with the root," he would have to eradicate the folly of heeding the mandates of fashion rather than the appeals of Nature.

THE MORALITY OF HAPPINESS.

BY THOMAS FOSTER.

EVOLUTION OF CONDUCT.—(CONTINUED.)

THERE is only one way of escape from the conclusion reached in our last—that conduct is good or bad according as its total effects are pleasurable or painful—in which statement be it understood the word total *means* total, and is not limited in its application to the person whose conduct is spoken of. If it is supposed that men were created to suffer, that a power which they were bound to obey had planned such suffering, so that any attempt either to take pleasure or to avoid pain was an offense, then of course the conclusion indicated is an erroneous one.

No system of religion has ever definitely taught so hideous a doctrine. Even where sorrow and suffering are recognized as the lot of man, and even where self-inflicted anguish and misery are enjoined as suitable ways of pleasing Deity, it is never said that such sufferings are the ultimate desire of the Supreme Power. These tribulations are all intended for our good: we are to torture ourselves here and

now, that hereafter we may avoid much greater pains or enjoy much greater pleasures than here and now we could possibly experience.

Yet underlying this doctrine of greater and longer-lasting happiness as the result of temporary suffering or privation, there has been and is in many so-called religions the doctrine that pain and suffering are pleasing to the gods of inferior creeds and even to the Supreme Power of higher beliefs. The offerings made systematically by some races to their deities imply obviously the belief that the gods are pleased when men deprive themselves of something more or less valued. Sacrifices involving slaughter, whether of domestic animals or of human beings, mean more, for they imply that suffering and death are essentially pleasing to Deity. Even when such gross ideas are removed and religion has been purified, the symbolization of sacrifice in most cases takes the place of sacrifice itself. The conception may and often does remain as an actually vital part of religious doctrine that pleasure is offensive to the Supreme Power and pain pleasing.

If this conception is really recognized, and any men definitely hold that to enjoy or to give pleasure is sinful, because displeasing to God, while the suffering or infliction of pain is commendable, then for them —but for them only—the doctrine is not established that conduct is good or bad according as its total effects are pleasurable or painful. But if there are such men, then they are mentally and morally the direct descendants of the savage of most brutal type, who, because he himself delights to inflict pain, deems his gods to be of kindred nature and immolates victims to them (or, if necessary to gain his ends, shows the reality of his belief by self-torture) to obtain their assistance against his enemies.

If there are such men among us still, then, as Mr. Herbert Spencer says, "we can only recognize the fact that devil-worshipers are not yet extinct." The generality of our conclusions is no more affected by such exceptions as these than it is by the ideas which prevail in Bedlam or Earlswood.

But on the one hand the doctrine thus reached may be passed over as a truism (which it ought to be and indeed is, though, like many truisms, unrecognized); and on the other it may be scouted as Epicurean (which is unmeaning nonsense, however) and as mere pig-philosophy. For it sets happiness as the aim of conduct, and, whether self-happiness or the happiness of others is in question, many find in the mere idea of pleasure as a motive for conduct something unworthy —thereby unconsciously adopting the religious doctrine which has been justly compared with devil-worship.

This expression—Pig-philosophy—has indeed been applied to the doctrine we are considering, by a philosopher who, with Mr. Ruskin and Mr. Matthew Arnold, may be regarded as chief among the wonders of our age—and standing proof of the charm which the British race finds in Constant Grunt, Continual Growl, and Chronic Groan.

It must be considered, therefore, as certain that to some minds a philosophy which sets the happiness of self and others as a worthy end must appear unworthy. Such minds find something pig-like in the desire to see the happiness of the world increased. Yet grunting and groaning are at least as characteristic of the porcine race as any desire to increase the comfort of their fellow-creatures or even their own. Mr. Herbert Spencer's lightsome pleasure-doctrine, the essence of which is that we should strive to diminish pain and sorrow (our own included) and to increase joy and happiness, is less suggestive of porcine ways (at least to those who have noted what such ways are) than—for instance—the following cheerful address to Man: "Despicable biped! what is the sum total of the worst that lies before thee? Death? Well, Death; and say the pangs of Tophet, too, and all that the Devil and Man may, will, or can do against thee! Hast thou not a heart; canst thou not suffer whatsoever it be; and, as a Child of Freedom, though outcast, trample Tophet itself under thy feet, while it consumes thee?" Were this but stern resolution to endure patiently, and even cheerfully, such sorrows as befall man, it were well. Nay, it would fall in with the philosophy of happiness, which enjoins that for their own sake as for the sake of those around them men should bear as lightly as they may their burden of inevitable sorrow. But what Carlyle calls the New-birth or Baphometic Fire-baptism is not Patience but Indignation and Defiance. This is the veritable Pig-philosophy: the "Everlasting No" (*das ewige Nein*) is in truth the Everlasting Grunt of dyspeptic disgust, the constant Oh-Goroo-Goroo of a jaundiced soul.

Are the teachings of living professors of the Everlasting Groan school brighter than those of the gloomy Scotsman? Here are some of the latest utterings of the chief among them: "Loss of life!" exclaims Mr. Ruskin, cheerfully. "By the ship overwhelmed in the river, shattered on the sea; by the mine's blast, the earthquake's burial—you mourn for the multitude slain. You cheer the life-boat's crew; you hear with praise and joy the rescue of one still breathing body more at the pit's mouth; and all the while, for one soul that is saved from the momentary passing away (according to your creed, to be with its God), the lost souls yet locked in their polluted flesh haunt, with worse than ghosts, the shadows of your churches and the corners of your streets; and your weary children watch, with no memory of Jerusalem, and no hope of return from *their* captivity, the weltering to the sea of your Waters of Babylon." *Oh! Goroo! Goroo-oo!*

Any philosophy which hopes for other than misery and disgust in life must indeed seem strange doctrine to teachers such as these—even as the smiles of the cheerful seem unmeaning and offensive to those whose souls are overcast with gloom and discontent. Sir Walter Scott tells a story of his childhood which well illustrates the unreason-

ing hatred felt by the Everlasting Growl school for the doctrine that conduct should be directed to the increase of happiness. One day, his healthy young appetite made him enjoy very heartily the brose or porridge of the family breakfast. Unluckily, he was tempted to say aloud how good he found his food. His father at once ordered a pint of cold water to be thrown in, to spoil the taste of it! Possibly he meant to inculcate what he regarded as a high moral habit; but rather more probably Mr. Walter Scott, Sen., objected to his son's enjoying what he had no taste for himself. Much of the sourness of the Growl Philosophy may be thus interpreted.

V.—SELF *VERSUS* OTHERS.

We teach our children, the preacher tells his flock, but few follow the precept—Care more for others than for self. It sounds a harsh doctrine to say, instead—Each must care for himself before others. Yet it is not only true teaching, it is a self-evident truth. It would not be even worth saying, so obviously true is it, were it not that in putting aside the doctrine because of its seeming harshness men overlook, or try to overlook, the important consequences which follow from it.

If a man's whole soul—nay, let me speak for a moment in my proper person—if my whole soul were filled with the thought that my one chief business in life is to make those around me, as far as I can make my influence felt, as happy as possible, to increase in every possible way the stock of human (nay, also of animal) happiness, I must still begin by taking care of myself. For if, through want of care, I myself should cease to exist, I can no longer, in any way, serve others; nay, it is even conceivable that my immature disappearance from the scene of my proposed exertions for others' benefit might cause some diminution of the totality of happiness.

If the very thought of care for self should suggest that there can be no real love or care for others where self-care comes first (self-evident though the proposition be that care of self *must* come first), let us replace the case rejected as imaginary by a concrete and familiar illustration.

None can question the unselfishness of the love which a mother feels for her infant babe. None can doubt that, if question arose between the babe's life and hers, her own life would be willingly sacrificed. Of course there are exceptions, perhaps many, but no one can doubt, and multitudes of cases have proved, that the rule holds generally. Now, the nursing mother not only has, in her very love for her babe, to take care of herself, but to care for herself *first*, and to take more care of herself than, but for her pure, unselfish love for her child, she would have troubled herself to take.

Let this case suffice to show that care of self before others (not, therefore, necessarily more than others), besides being a self-evident

duty (which many may regard as a mere trifle), may be not only perfectly consistent with regard for others, and even with devotion to others, but may be absolutely essential to the proper discharge of our duties toward others. In fact, it is little more than a truism, instead of being, as many would at a first view imagine, a paradox, that the more earnest our wish to increase the happiness of others, the more carefully must we look after our own welfare.

If we take a wider view, and, instead of considering a single life, study the development of families and races, we still find the same lesson. As the man who wishes his life to be useful to his fellows and to increase their happiness must take care of that life, so he who would wish to benefit humanity through his family or race must not only nourish his own life and strength, but must develop those activities which advance his own welfare and the welfare of his family. Otherwise come, inevitably, the dwindling of the faculties on which his own value depends, and the loss in his descendants of good qualities which they might otherwise have inherited from him. Or it may be that such qualities are inherited in less degree than had he duly exercised powers and capacities which were in a sense held in trust for them. We are apt to overlook the importance of individual action in such cases, not noticing that the progress of a race depends on the aggregate of acts by the individual members of the race.

To take a concrete instance here, as of the simpler case: If a number of persons in any nation or at any epoch, impelled by a desire to benefit their fellows, devote their lives to celibacy, they influence in important degree the qualities of the next and succeeding generations. They diminish the proportion in which their personal qualities—presumably valuable—will appear in future generations, and relatively increase the proportion of other and less desirable qualities. This is obvious enough. It should, however, be almost as clear that, in whatever degree such persons in a community as possess the best qualities fail to advance, in all things just, their personal interests, they diminish the influence of the better qualities, not only in their own time, but in times to come. If, to take another concrete example, all persons of the better sort, forgetting their duties to themselves and their race, enter of set purpose on lives of poverty, asceticism, and dreariness, they not only diminish in large degree the good they might do during life, but they injure their offspring, and, through them, posterity.*

Under its biological aspect, then, the doctrine that care of self must necessarily take precedence of care and thought for others, is incontestable—it is the merest truism—though many speak, and some act, as if the doctrine were iniquitous.

* Many would probably be startled if a just estimate could be formed of the degree in which the qualities of the civilized races of the world have suffered through the well-meant but mistaken zeal which led large classes of men in former ages to sacrifice their *power* to do good in *order* to do good.

But this doctrine has its moral aspect also. The question of duty comes in at once and very obviously so soon as the actual consequences of conduct have been shown to be good or bad. But it may be well to show more definitely what the true line of duty is in regard to self. I shall, therefore, next consider cases where self-abnegation leads directly to the diminution of general happiness.—*Knowledge.*

WHY THE EYES OF ANIMALS SHINE IN THE DARK.

By SWAN M. BURNETT, M. D.

THAT the eyes of some animals, particularly the cat, are luminous when they are in the dark, is a fact established from time immemorial. It is surprising, however, to find the exact nature of the phenomenon entirely misunderstood even by scientists whose lines of investigation lie in the particular field to which it belongs. In conversing, not long ago, for instance, with one of the first physicists of this country, who is at the same time an ardent sportsman, he gave me a graphic description of a "still hunt" for deer. This method of hunting, as is well known, consists in placing a bright light in the bow of a boat and propelling it noiselessly through the water. The deer is attracted by the light and goes toward it, but is prevented by its glare from seeing his enemies who are concealed in the shadow. The hunter, looking straight ahead, sees in the outer darkness—rendered Egyptian by contrast with the bright light immediately in front of his own eyes—two large, luminous bodies, like balls of fire. These are the eyes of his victim; and, making his calculation as to the distance from the eyes down to the breast, the valiant sportsman (who probably is also a strong anti-vivisectionist) fires, intending to send his bullet through the heart. The eminent physicist, in speaking of this luminosity, referred to it as due to the *phosphorescence* of the eyes, in that final way in which we are accustomed to speak of things beyond dispute.

But it is hardly less surprising to read in the article "Light," in the ninth edition of the "Encyclopædia Britannica," the following remarkable statement by Professor P. G. Tait, on the *sources* of light: "3. A third source [of light] is physiological; fire-flies, glow-worms, *medusæ*, dead fish (?)—the eye of a cat" (vol. xiv, p. 379).

If these are the opinions of acknowledged authorities in optics, we can hardly expect the mass of even ordinarily intelligent and informed persons to have more correct ones, and should expect thorough credence to be given to the story of the man who claimed that he was able to recognize an antagonist who struck him in the dark by means of the light emitted from his own eye as the result of the blow.

The fact is, there is no phosphorescence in the eyes of animals—at least, so far as my knowledge extends, none has been demonstrated; and, that it is absent from the eyes of the cat, Professor Tait can demonstrate conclusively for himself, by taking a cat, be it ever so black (and these I believe are supposed to have the luminous power in the greatest degree), into a completely dark room where there can come no ray of extraneous light, and he will find that the eyes can not generate enough light to make even the darkness visible.

The real cause of the luminosity of the eyes of animals in the dark is now thoroughly understood by physiological opticists and by many practical oculists, and depends upon the well-demonstrated laws of the refraction and reflection of light. For a clear apprehension of the phenomenon, however, it is necessary to understand the properties of the eye as an optical instrument.

The office of the eye as an optical instrument, pure and simple, is to bring rays of light to a focus on the membrane at the back part known as the *retina*, in such a manner that small and inverted images of external objects shall be formed there. For this purpose there is a general plan, which is subject, however, to more or less variation in different animals. The basis of this plan is the *camera-obscura*, in which the box is represented by the hollow globe or ball of the eye, the small aperture through which the light enters, by the pupil, and the lens by which the inverted and reduced images of external objects are formed, by the refracting surfaces of the eye, which are usually two—the cornea, or clear part of the front of the eye, and the crystalline lens.

Now, the eye, in its capacity of optical instrument, is obedient to the same laws as any other apparatus reflecting and refracting light. It may astonish some to be told that the eye reflects the light passing into it. It was for a long time believed that all light that entered the eye was in some manner consumed there, and that none ever found its way out again. It was considered one of the functions of the choroid or pigmented coat of the eye to absorb such light as was not used in the formation of the image. The basis of this opinion was that, under ordinary circumstances, no matter how bright the light may be in which the eye is looked at, the pupil always appears black. But no fact is more clearly demonstrated now than that the eye does throw back a large part of the light which enters its pupil.

One of the fundamental principles of optics is what is called the law of conjugate foci. This is readily understood by means of the accompanying diagram (Fig. 1). If the object is at *a*, the lens *l* will form an image of that object at *c*. The law of conjugate foci is that the image can exchange places with the object and the object with the image, and the result be still the same. That is to say, if the object were placed at *c*, its image would be formed at *a*. Or, expressing it in another way, the rays of light follow the same lines,

whether going from the image to the object or from the object to the image.

Let us now apply this law to the case of the eye. We will suppose the eye to be in a normal optical condition; that is, that the retina on which the image is formed is to be found exactly at the focus of

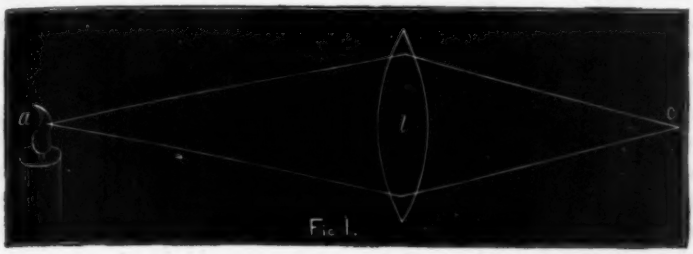


Fig. 1.

the lenses by which the light is refracted. By consulting Fig. 2, we can follow the course of the rays of light in both directions. We have rays going from *a* in the flame *a b*, which after refraction by the lenses of the eye are brought to a focus at *c*, and form the lower end of the inverted image; whereas, these going from *b* are united again at *d*. But, since the bottom of the eye is a reflecting surface, and sends back a part, at least, of the light which falls on it, some of these rays pass out again, but, in accordance with the law of conjugate foci, they must follow the same lines as in entering; therefore, the rays from *c* will come back to *a*, and those from *d* will come

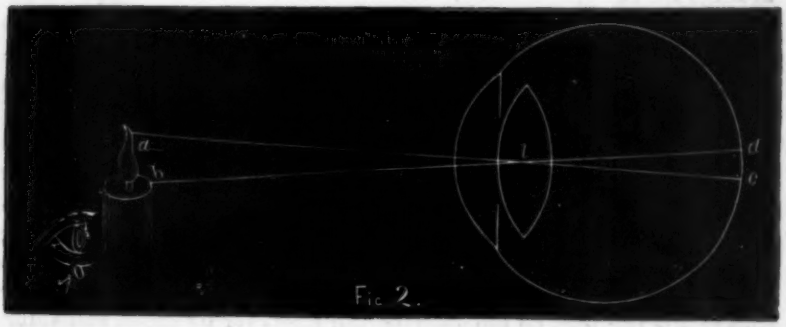


Fig. 2.

back to *b*. If we could place our eye at *a b*, then we would catch some of these rays, and the bottom of the eye would appear illuminated just as any other surface from which light was reflected. But our eye and the candle can not occupy the same place at the same time, and if we place it behind the candle, the flame itself cuts off the rays of light, and if we place it in front, our head obstructs the passage of the light to the eye to be observed. So, under these circumstances, it is impossible for an eye, at *o*, for instance, to get any of the light that is constantly coming from the bot-

tom of an eye which has been illuminated. But, if we were able by any contrivance to place our eye in the position of the source of light, we would be able to catch the rays coming from the bottom of the observed eye, and it would appear illuminated. Now, there is such a contrivance, and it is called the *ophthalmoscope*, and it owes its existence to the genius of Professor Helmholtz. The principle of its construction is so simple that the wonder is that no one ever thought of it before; but never, until the year 1851, had any one ever seen in anything like detail the interior of a living eye. If you take a piece of bright tin and punch a small hole in it, and, placing the hole directly in front of your own pupil, throw the light from a lamp into the eye of a child, the pupil, instead of appearing black as it usually does, will be of a beautiful yellowish-red color. This is because you have, to all intents and purposes, put your eye in the place of the source of light. For the light reflected from the surface of the tin is that which passes into the eye, and it must come back to it after reflection. The eye placed behind the hole catches the small quantity which would fall on that part, and therefore sees the surface from which it comes, illuminated. This is the principle of *illumination* of the bottom of the eye, and, when you have your object sufficiently well lighted, it is only a matter of optical appliance to see it distinctly and in great detail. This digression is designed to show that, when we have favoring circumstances, by the action of well-known optical laws, the eyes of animals appear illuminated, and that it is not necessary to call in the supposition of phosphorescence to account for the phenomenon.

But, in the case of some animals, the eyes appear to shine without the intervention of any optical means, however simple. This, however, is only apparent, for the principle of illumination is applicable here as in the other cases.

In the case we have supposed, the retina, which in this instance is the reflecting surface as well as the membrane on which the image is formed, was found at the focus of the refracting surfaces of the eye. But this condition is met with only in what is accepted as the perfect optical state of the eye. As can be readily understood, the retina may lie either in front or behind the focus of the refracting media—that is, the eye may be too long or too short for its focus, and unfortunately such conditions are but too common. When an eye is too long, it is said to be near-sighted or myopic; when too short, it is far-sighted or hypermetropic.

The change in the position of the retina, then, must exercise an influence on the direction of the rays that are reflected from it. From the well-demonstrated properties of lenses we know that, when rays of light coming from a point at the focus of a lens pass through it, they are rendered parallel; when they come from a point *within* the focus, they are spread out, or rendered divergent; and when from *beyond*

the focus, they are rendered convergent, or brought toward another focus.

In accordance with these laws, therefore, we must expect the rays of light to take a different course in coming out of an eye according as it is near- or far-sighted. The course of the rays coming from the far-sighted or hypermetropic eye is shown in Fig. 3.

If the retina lay in the focus of the refracting surfaces of the eye at E, then the light from the inverted image *c d* of the flame would travel back, in the same direction in which it came, to the flame *a b*

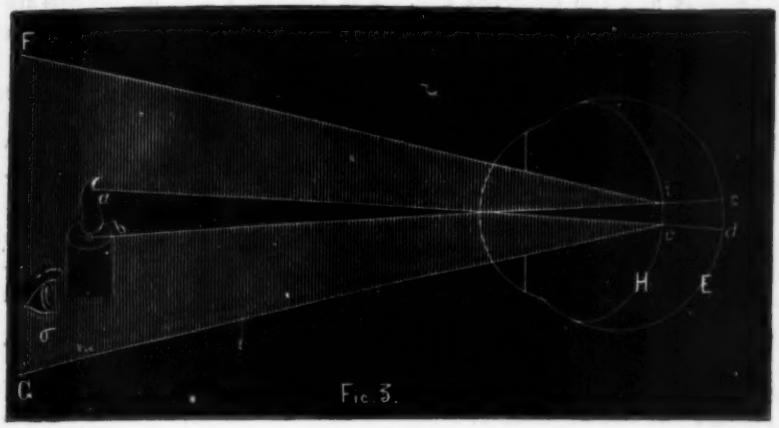


Fig. 3.

itself. If, however, it meets the reflecting surface of the retina *within* the focus at H, then the rays from the confused image *e i* would come out in a *divergent* manner, and form a cone of light, F G, like that from the head-light of a locomotive.

It is now easy to see that if an observing eye is placed anywhere in the vicinity of the source of illumination, as at *o*, it will take in some of the rays coming from *e i*, and see it illuminated. There are very few human eyes so accurately adjusted as to their focus that all the rays come back to the source of light; some of them are scattered, and by a very simple arrangement it is possible to catch them in sufficient number to show the bottom of the eye illuminated.

Place a child (because the pupils of children are large), and by preference a blonde, at a distance of ten or fifteen feet from a lamp which is the only source of light in a room, and cause it to look at some object in the direction of the lamp, turning the eye you wish to look at slightly inward toward the nose. Now, put your own eye close behind the lamp-flame, with a card between it and the flame. If you will then look close by the edge of the flame covered by the card into the eye of the child, you will see, instead of a perfectly black pupil, a reddish-yellow circle. If the eye happens to be hypermetropic, you will be able to see the red reflex when your own eye is at some distance to one side of the flame.

This is the true explanation of the luminous appearance of the eyes of some animals when *they* are in comparative obscurity. It is simply the light *reflected* from the bottom of their eyes, which is generally of a reddish tinge on account of the red blood in the vascular layer of the choroid back of the semitransparent retina, and not light that is generated there at all. This reflection is most apparent when the animal is in obscurity, but the observer must be in the light, and somewhat in the relative position indicated in the above-described experiment—that is, the eye of the observer must be on the same line with the light and the observed eye. The eyes of nearly all animals are hypermetropic, most of them very highly so, so that they send out the rays of light which have entered them in a very diverging manner.

The circumstances under which the phenomena of luminosity are usually seen are, it will be noted, those most favorable for the success of the experiment. The animal is always in an obscure corner, under a table or chair, as in the case of the cat, while the deer is in the outer darkness of the night. It is well known that the pupils dilate when in the dark, and they often attain an immense size in the eyes of those animals with nocturnal habits, and the size of the cone of light is governed by the size of the pupil, since its circumferential boundary is formed by it.

In making some experiments on dogs and cats, for the purpose of determining the size of this cone of light, I found that it had actually about twice the diameter it should have theoretically, from the amount of hypermetropia present, as determined by means of the ophthalmoscope. This I can account for only by the great dispersion of light at the periphery of the lens and cornea, rendered possible by the immense dilatation of the pupil; and this I think, too, is the reason why the phenomenon is not more frequently observed in the higher animals affected with hypermetropia. The pupil in man never attains the size, under the same circumstances, as that of the cat, for example; and, moreover, it is most likely that the surfaces of the cornea and lens are more regular in their curve, even at their more peripheral parts, and consequently disperse the light in a very much less degree.

PREHISTORIC ART IN AMERICA.

By the Marquis de NADAILLAC.

THE world of science was astonished a quarter of a century ago by the discovery made in the caves of Vézère, France, of works of art executed by the prehistoric troglodytes. The specimens consisted of representations of mammals, birds, fishes, and of man himself, sculptured in relief or engraved upon elephants' tusks, bears'

teeth, the shoulder-blade of a reindeer, the long bones of deer, or on stones or beach-pebbles, and included the huge cave-bear, the mammoth with its heavy mane and upturned tusks, the seal, the crocodile, and the horse. These drawings, the first efforts of man, are crude in shape, but suggestive of vital action. One of the stag-horns, engraved with representations of reindeer and fishes, is a almost a masterpiece. The deer are following one another, and one of them has turned to look back, doubtless so as to see her fawn; the heads are all drawn in profile and without foreshortening, as in the Egyptian paintings and sculptures; sometimes the lines are light, at other times they are cut deeply to bring out certain parts. By a curious caprice the artist, after having completed his first design, has put fishes in all the vacant spaces, and they too are wonderfully truthful. M. Massenat has discovered, at Laugerie Basse, a piece of reindeer-horn about ten inches long, on which was plainly engraved an aurochs running from a young man who is about to shoot an arrow at it. The animal has its head down with its horns in a position of menace, expanded nostrils, and tail raised and curved, all being signs of terror and irritation. The man is naked and has a round head, with coarse hair, which is brought up over the top of his head, and an obvious beard on the chin. His whole physiognomy expresses joyousness and the excitement of the chase. The women have flat breasts and prominent hips. One of them, very hairy, is drawn between the legs of a deer, and wears a collar around her neck. Unfortunately, her head is wanting.

A considerable number of engraved stones and bones have been brought to light in the excavations of the cave of Thayngen, Switzerland. Among them is a reindeer, standing with its head inclined toward the ground, and drawn with a precision showing a really remarkable acquaintance with the form of the animal. The artist had attained such perfection that observers were at first tempted to ask if they had not been invited to look at one of the archæological frauds that have unhappily become so common. But the excavations had been watched with unremitting care; the witnesses of the discovery were honorable men of science; the calcareous deposit of more than a yard thick had been taken up under their eyes; there were found in the cave reproductions of animals which had disappeared centuries ago—the musk-ox, for instance; and the engraving was so faithful that it could have been made only from nature. It was necessary, then, to surrender to the evidence. Away back in the quaternary ages, in the midst of the hardest conditions of life, of the struggle for existence, and of incessant conflicts against the great pachyderms, the bears, and the feline animals that swarmed around him, man already had the feeling or the instinct of art. He tried to draw the likenesses of the animals he saw and of the trees that shaded the cave he lived in; and the productions of his industry, found again after so many ages, are all the more interesting from the fact that the extemporiz-

ing artist had, to assist him in his work, only some wretched flints or roughly-sharpened bones. The inquiry whether these discoveries made in the west of Europe are verified in other countries, and whether this art-feeling was innate in man and has characterized him always and everywhere, is one of much interest. The excavations in Asia and Africa are still too few, and the discoveries that have been made there are of too little importance, to warrant the drawing of serious conclusions respecting those quarters. We must, then, turn to America, where eminent archæologists and enthusiastic collectors have eagerly studied all that relates to the past of the human race. With the aid of their publications and the photographs they have distributed with rare liberality, we are able to follow the ancient populations in their migrations from the shores of the Atlantic and the Pacific, to study their habits and their progress, and to show that among them also art was born at a very early epoch, and that it grew up with the generations.

It has now been ascertained that man lived in America during the quaternary ages, contemporaneously with the mastodons and the huge edentates and pachyderms, which had no other resemblances with the mammals of the Eastern continents than those of size. Like their contemporaries in Europe, the primitive Americans wandered in the solitary wilderness, and disputed with animals for the prey on which they fed and the caves that sheltered them, having for weapons of offense and defense only the flints that lay at their feet. Their barbarism appears to have been lower than that of the troglodytes of Europe, and to have been destitute of all artistic feeling and taste for ornament. Ages passed, the duration of which we can not compute; the quaternary animals disappeared, and man became sedentary; and he has left as evidences of his long abode in the same place the heaps of refuse exemplified in the shell-mounds and kitchen-middens of the Atlantic coast, the Gulf of Mexico, the banks of the Mississippi and the Amazon, the Pacific coast, and Tierra del Fuego. Excavations made at several points have brought out hatchets, knives, harpoons, and tools of every shape, of stone, bone, and horn, all bearing witness to a backward social condition, fragments of carbonized wood, bones of animals, and fish-bones, all having evidently been accumulated by men who knew nothing of agriculture and lived by hunting and fishing. Occasionally a few shards of pottery have been found among the remains, made of clay mixed with pounded shells, fashioned by hand, and dried in the sun. Sometimes plaited vines or canna-stems have been impressed on the wet parts, or lines have been scratched on the vessel with the point of a shell or a flint. These are the first efforts at ornamentation, and are singularly like those of the most ancient potteries of Europe. Ornaments designed for the decoration of the person are more rare than the potteries. We can only cite a few bears' or cats' teeth and shells bored for the purpose of being hung from the neck, except in the *sambaquis* or kitchen-middens of Brazil, where a

few figures of fishes and idols in gold and silver have been found in very ancient deposits of guano.

We can form only the most imperfect estimates of the dates of these remains. Geological evidences give no definite clew. The growth of trees over the kitchen-middens may fix dates previous to which they certainly existed, but when we have admitted the five or six centuries it took the trees from the time the wind wafted the seed to the spot, how are we to compute the number of generations of plants that were required to furnish the soil on which they could grow? One point only is ascertained, and that is that no bones of quaternary animals have been met under the kitchen-middens, and, with the exception of the figures we have mentioned, no metallic objects. The remains must, then, have been accumulated between the period of the disappearance of the larger animals and the time when the metals came into habitual use. Must we say, then, that during that long series of ages no artistic tendency revealed itself in man? Yes, if we judge by the individual objects that have been collected; no, if we attribute to that epoch the pictographs, or the figures, scenes, hieroglyphics, or rebuses, as we might call them, which are painted, engraved, and sculptured on the cliffs, the sides of caves, the bowlders, and erratic rocks, or wherever a vacant space may have been offered to the artist. Men have at all times with a childish vanity endeavored to delineate their migrations, their contests, their hunts, and their victories. Egypt has transmitted its ancient history to us on granite; the rocks of Scandinavia still wear the likeness of the Vikings' vessels; and those around the *lac des Merveilles*, near Nice, bear pictures of men extremely primitive in design; curious engravings have been noticed in Algeria; the Bushmen, who are among the most degraded populations of the globe, have drawn on stone, with wonderful fidelity, their hunting scenes and their loves; and the rock-paintings of New Zealand, the work also of a barbarous race, but evidently superior in execution to the scratches of the Bushmen, have been described before the London Society of Anthropology. These are isolated facts, though curious ones; but in the two Americas the number of pictographs and the extent of surface they cover give them an exceptional importance. The desire, not only to reproduce striking events, but also to give precision to their sense by conventional signs, by graphic strokes, or by hieroglyphics or phonetic or symbolical characters, is one of the most remarkable traits of the different races that have succeeded each other on the new continent. Although the initial date of these engravings is unknown, we can nevertheless affirm that they continued to be executed through many ages, and that while the most ancient ones ascend to remote epochs, in some instances these historic drawings only a little while preceded the arrival of the Europeans. Pictographs are especially abundant in the regions that formerly constituted Spanish America: in Nicaragua, near the extinct volcano of Masaya; in the

United States of Colombia, on the banks of the Orinoco; and in Venezuela, where in consequence of their antiquated condition they will soon cease to be distinguishable. The rocks of Honduras are covered with sharply-cut designs; the *conquistadores*, in 1520, remarked similar works in the Isthmus of Darien; and in the State of Panama entire cliffs were charged with hieroglyphics that might afford matter for very interesting studies. In the Sierra Nevada, between Columbus, Nevada, and Benton, California, are hosts of figures of men and animals and uninterpretable signs. About twenty miles south of Benton, the road follows a narrow defile, bounded on both sides by nearly perpendicular rocks, and these are covered with figures in respect to which no clew exists as to the people that designed them.

Pictographs are little less numerous in Arizona, New Mexico, and Colorado—in parts of the country which, though now desolate, were formerly inhabited by a considerable population. The glacier-polished bowlders of the valley of the Gila River have figures that may be compared with those of Thuringia. On the banks of the Mancos and the San Juan, and in the deep cañons stretching up toward the east, the figures are visible at dizzy heights, some deeply engraved, others drawn in red or white. Among them is a procession of men, animals, and birds with long necks and legs, all going in the same direction. Two of the men are standing on a sledge drawn by a deer, while others direct the march of the drove. The artist evidently intended to represent a migration of his tribe. In another pictograph on the banks of the San Juan, among figures of strange forms and of drawing incorrect but full of movement and life, may be recognized a number of flint hatchets, exactly similar in pattern to the symbolical hatchets that are cut on the megaliths of Brittany. At another spot, a cliff is covered, for a space of more than sixty square feet, with figures of men, deer, and lizards; and M. Bandelier has seen, near the ruins of Pecos, pictographs, the high antiquity of which is attested by the degree of effacement they have undergone. They represent the tracks of men or children, a human figure, and a tolerably regular circle. On the banks of the Puerco and the Zuñi, two of the affluents of the Colorado Chiquito, designs have been remarked having the appearance of hieroglyphics, but their significance is unknown, and we can not even affirm that they had any. The cliffs near Salt Lake in Utah are adorned with sculptures, among which are human figures of the natural size, cut in a hard rock more than thirty feet above the ground. All together show an amount of labor of which the Indians are incapable, and a sum of difficulties which they could not have overcome; and the height at which some of the sculptures appear allows the supposition that some geological phenomenon, perhaps a depression of the lake, may have occurred since they were executed. Many drawings on stone have also been observed in the eastern parts of the United States.

Pictographs to which we are disposed to accord a great antiquity are to be seen on the sides of caves in Nicaragua. Some grottoes in the mountains of Oajaca also bear witness to the labor of man, in the shape of coarse paintings in red ochre. Among them is frequently repeated the imprint in black of a human hand. This imprint, which is probably borrowed from some myth, seems to have played a great part in America. It is found reproduced in regions very remote from one another, standing out on the potteries, sometimes in red on a black ground, sometimes in black on a red ground. In our own days it is occasionally found in use among Indians as a totem or coat-of-arms.

All that we have just said bears witness to a still primitive condition of art. The men who executed the works, barbarous as they seem to have been, were capable of rising higher. This is proved by works of a manifestly later epoch. Guatemala, the ancient land of the Quiches and the Cakchiquels, abounds in ruins. Bas-reliefs, statues, and monoliths covered with arabesques to the height of twenty feet, meet the traveler frequently. At Quirigua, a small port on the Bay of Honduras, a statue of a woman has been found, footless and handless, with a crowned idol on its head; excavations by the side of it have brought to light a tiger's head in porphyry. At Santa Lucia Cosumalhuapa, at the foot of the Volcan de Fuego, among the cyclopean stones and the statues of tapirs and caymans, lie colossal stone heads, of a strange type, hitherto unknown. Two of these heads wear the immense ear-rings peculiar to the ancient Peruvians, and a head-dress similar to the Asiatic turbans. Farther on are bas-reliefs in hard porphyry, larger than nature, representing personages as odd in conception as in execution, and mythological scenes that have no relation to any known form of worship. The most interesting bas-relief represents a human sacrifice. The principal personage is a priest; he is naked and, according to the custom of the Aztec priests, wears a garter around his left leg; only the left foot is shod. The head-dress is a crab. One hand holds a flint, doubtless the sacrificial knife, while the other hand grasps the head of the victim to be slain. On a second plane, two acolytes are carrying human heads. One of them is a skeleton, a sinister symbol of death. Its head is of a simian shape, mingling the grotesque with the terrible. To cite more similar facts would merely involve unpleasant repetitions. We shall only add, then, that the figures are of a grinning aspect and a repulsive ugliness. The ancient American races did not seek for the beautiful, or, rather, did not comprehend it as we do, who have been taught by the immortal creators of the high art of Greece.

We have just occasion to be surprised when we think of the time that was required to execute these works, and consider what inefficient mechanical means the artists had to use. They had to detach blocks of hard stone by means of wretched tools of quartzite and obsidian, and to saw granite and porphyry with agave-fibers and emery. A

coarse outline design indicated the part to be removed. The labor was executed either by sawing partly through the stone and deftly breaking off the fragment, or by pecking it away with a flint-point. Lastly, the surface of the planes was rubbed with flat stones or polishers to remove the traces of the chippings. Other processes also appear to have been employed. The artist drew his figure in coarse tracings, and covered with ashes the lines he desired to bring out in relief. The whole surface was then heated with fire; the parts which were subjected to the direct action of the flames were decomposed, and left hollow places, while those that were protected by the ashes remained intact.*

For finishing his work, the sculptor had nothing better than a flint-point or a copper chisel,† the only tools in use, for iron was unknown. He was obliged, in order to execute those colossal figures and the bas-reliefs which now make such an impression of astonishment upon us, to cut with those imperfect tools in a very hard rock to a depth of three or four centimetres. The fact of the performance of a labor of such length is a certain indication of the infancy of the society in which it was done, where man had not yet learned to appreciate the value of time.

The region of the *piedras pintadas* (painted stones) in South America extends from Guiana to Patagonia. They are found in the wilds of Brazil and La Plata as well as in the more civilized districts of Peru and Chili, and they betray everywhere a remarkable analogy. In the solitudes of Pará and Piauhy, Brazil, are numerous intaglio-sculptures, executed by unknown peoples; they represent animals, birds, and men, in various attitudes. Some of the men are tattooed; others wear crowns of feathers; and the picture is finished off with arabesques and scrolls. At la Sierra da Onça are drawings in red ochre, isolated and in groups, without apparent order, and the rocks of the province of Ceará and those of Tejuco are covered with tracings not unlike those on the rocks of Scandinavia. Humboldt describes intaglios on the right bank of the Orinoco, representing the sun and moon, pumas, crocodiles, and serpents, ill-formed figures defined most frequently by a simple outline and declaring little advancement in art. Nevertheless, since they are cut in the hardest kind of granite, it is

* Mr. Wiener saw the natives excavating an irrigation canal in the valley of Chicama de Sausal, through a rock which stood in the way. The workmen piled ashes along the line of the edges of the canal, covered them with dried manure and burned it. After eight days they succeeded in forming by this process a channel through a granite rock containing a vein of basalt 1·20 metre wide, 0·80 metre deep, and 2·30 metres long.

† There has been found near Quito a chisel that was used in working the large blocks of trachyte employed in paving the roads of the Incas' empire. It weighed 198 grammes. The surface was worn, the edge was nicked, and the head appeared to have been hammered upon, all indicating that it had been subjected to long use. An analysis of a piece of it by M. Damour gave ninety-five parts of copper, a little more than four parts of tin, and slight traces of iron, lead, and silver..

impossible to attribute them to the barbarous tribes that inhabited the country at the time of the arrival of the Europeans. These tribes were incapable of executing works of this kind, and even of comprehending any art, however crude it may appear to us. Who, then, were the peoples to whom we can attribute the painted stones? What was their origin? The illustrious German traveler tells us nothing that can diminish our ignorance on this point.

There are mentioned as among the works in the country of the Chibkas, in the United States of Colombia, a stone probably designed for sacrificial purposes, and sustained by caryatides, a jaguar sculptured at the entrance to a cave near Neyba, and gigantic llamas. In the land of the allied tribe of the Muiscao, the granitic and syenitic rocks are adorned with colossal figures of crocodiles and tigers, guardians doubtless of the images of the sun and moon, the supreme gods of the South American natives. All of these figures are coarsely executed, and betray, like the North American figures, an extreme absence of taste and an absolute inability to reproduce objects faithfully.

Abundant examples occur on the Pacific coast of an art which we can best compare with that of Guatemala. A granite block near Macaya, known as the Piedra de Leon, is covered with sculptures which all are agreed are very ancient. The most important group represents a face-to-face struggle of a man and a puma. The figures suggest movement, and the man and the animal appear to be really struggling. Near the little city of Nepen may be seen a colossal serpent; a short distance from Arequipa, trees and flowers; farther on, bisons with bored noses are wearing movable rings cut in the same stone. At the Pintados de las Rayas, geometrical figures, circles, and rectangles, the meaning of which can not be defined, take the place of figures from life. In the province of Tarapacá, considerable surfaces are covered with figures of men and animals mostly fairly good specimens of work, and with a kind of characters arranged vertically. The lines are from twelve to eighteen feet long, and each character is quite deeply engraved. This is not an isolated instance. Inscriptions very much worn have been found near Huara, and between Mendoza and La Punta, Chili, is a large pillar on which letters have been imagined analogous in some respects with the Chinese alphabet. These evidences are very vague, and, however well disposed to discover in them the beginnings of graphic art, we can not as yet found so important a conclusion upon them.

The use of colors was certainly known to the Americans from the most remote antiquity. The ochres, soot-black, and lime doubtless furnished them their first coloring elements, and there was nothing in the idea of using these pigments above the most primitive conceptions. Experiment induced a rapid progress, and men learned to extract vegetable colors from leaves, fruits, roots, stems, and seeds. A coloring-matter was also borrowed, like the Tyrian purple, from sea-mol-

lusks. The Peruvians and the Mexicans knew how to place the colors upon their cloths. The goods were then exposed to the action of the light, and tints varying from a delicate rose-color to a dark violet were obtained. The colors were so well fixed that they were not even modified by the decomposition of dead bodies. In the collection of cloths from the Peruvian *huacas* at the museum of the Trocadéro, in Paris, wrappings of mummies that have been buried for centuries still retain the primitive color on their time-eaten threads.

The Mexicans probably obtained the remarkably brilliant coloring of their pictographs by somewhat analogous processes. These pictographs, manuscripts of which only a smaller number have reached us, embrace the history of the country, its national traditions, the genealogies of its kings and nobles, the rolls of provincial tributes, the laws, the calendar, religious festivals, and the education of the children—a complete summary, in fact, of all that concerns the manners, customs, and life of the people. They were painted in various colors on cotton cloth, on prepared skins, or on a strong and tough paper made from the fibers of the agave. At times the artist depicts scenes from real life; at other times he records facts by means of hieroglyphical, symbolical, or phonetic characters, conventional signs that have been handed down for generations, and on which innovation is prohibited. Another series of pictures illustrates the education of children and their food and punishments. The father teaches his son to carry burdens, to steer a canoe, or to manage the fishing-tackle. The mother instructs her daughter in domestic duties; she sweeps the house, prepares *tortillas*, and weaves cloths. These pictures present the distinct outlines and bright colors which the Americans sought first of everything. Evidently we must not ask them for models of decorative painting. Their complete ignorance of proportions and the laws of perspective demonstrates that their art was the exclusive product of their own genius, or of the instinct of their race, and that they had not been subject to any foreign influence.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

RECENT GEOLOGICAL CHANGES IN WESTERN MICHIGAN.

By C. W. WOOLDRIDGE, B. S., M. D.

WESTERN Michigan is a region noted for its lumber, its peaches, and its sand. It has other claims, however, to the attention of those who are interested in the workings of Nature, that are not nearly so well known as they deserve to be, for it bears the marks of very extensive geological changes in recent times, which are even yet in progress, but have not attracted the attention that their im-

portance merits, and have been overlooked altogether by some geological writers, whose observations might be expected to cover their field. Let us take a look at this region and examine briefly some of the marks in which Nature has written its history. We find it in the main a sandy plain, wooded with white-oak, beech, maple, hemlock, and pine, varying in the proportion which they bear to one another, and interspersed with other trees and undergrowth in all the variety which the prolific flora of that region affords. In places the land sinks so low as to constitute a timbered swamp, and in others it rises to a moderate height above ground-water; often it appears, as indicated by the vegetation it bears, to be very fertile, but occasionally it is almost naked in its barrenness. Taken as a whole, it is of a lower degree of fertility than the heavier soils found in the more central and southern parts of the State, and for this reason it is less generally under cultivation than it otherwise would be.

This plain is, however, interspersed with tracts of land of a very different character. These consist mostly of a clayey loam, containing bowlders, as the sandy levels generally do not, having a more rolling and irregular surface, and, so far as it has been the writer's privilege to observe them, lying at a higher level than the sandy plain by which they are surrounded.

On scanning the map of Michigan, it will strike one as a peculiar feature of this west side of the State, that nearly every stream, large or small, that flows into Lake Michigan, expands into a small lake near its mouth, a fact that may have given rise to a query in some as to why such a peculiar feature should exist, especially in a country all of whose features are post-glacial—carved, indeed, out of the glacial drift or built upon it everywhere; and it is with the hope to throw some light on this matter, as well as other peculiarities of the region, that this article is written.

Our principal field of observation is the country near Whitehall, Muskegon County, Michigan, where the writer began to reside in the summer of 1878. This village is situated at the head of White Lake, on White River, which opens into Lake Michigan some six miles to the southwest.

In this river-lake one may see in many places an old water-line on piling, which at that time was at an elevation of three feet or more above the water. The fact that this line was continuous at a uniform level on lines of piling that were apparently undisturbed rendered the theory of uplifting by ice that was often given in explanation of it exceedingly unsatisfactory; and when old residents of the neighborhood were heard to speak, as they often did, of schooners loading and unloading, a few years before, in places where there was not at this time water enough to float a raft, it left very little room for doubt that this old water-line recorded a real change of relative level between the water and the land.

On passing along the borders of the lake, however, another phenomenon was observed that seemed to contradict this hypothesis, or to indicate that the change of level had been the other way. This was the existence of the stumps of large trees, evidently in the position where they had grown, but at this time standing in the water. And again, a living witness was found to corroborate the testimony of the stumps, in the person of an old resident who tells of the willows growing far out on what is now a shallow in the lake, and forming a haunt that the deer used to frequent in the years when this country was first settled.

That summer (1878), a new trestle was built across the head of the lake for the Chicago and West Michigan Railroad. In building it piles were driven and sawed off beneath the surface of the water for the bottom sill of each bent to rest upon, but before the next spring these piles began to lift their heads out of the water, and, before the summer of 1879 had passed, the sills that rested on them were lifted from ten to fourteen inches above the water-level. During the summer of 1879 an iron swing-bridge was built across the mouth of White River, at the head of the lake, and, as a foundation for the turn-table, a bed of piling was driven in the center of the channel, which was sawed off at a considerable depth below the surface of the water. On this piling a platform of lumber was built, so that its surface, when completed, was at a depth of some six inches below the surface of the water, and on that a tower of stone-work was built for the turn-table to rest on. As the lake was considered to be at a low level at this time, it was supposed that this platform would be perpetually under water; but the bridge was not yet completed when it began to rise above the surface, and, by the next spring, it was some eight inches above the water-level. At this point, however, the water again began to rise, and at present this platform is again under water.

Another matter must now claim our attention, that speaks of a time somewhat more remote; but first, perhaps, it will be as well to glance briefly at the immediate border of Lake Michigan. Here, along the border of the low-lying, sandy country, there is generally a strip, varying from a few rods to half a mile or more in width, on which the sand has been piled up by the wind into dunes. Here the surface of the ground is fantastically irregular. Sharp crests, gorges, valleys, and crater-like depressions abound everywhere, and the whole is generally covered with forest and filled in with a rank undergrowth. In places, however, especially at the foot of the river-lakes, the sand is yet without vegetation, except here and there, on some sheltered slope, a few bunches of beach-grass or a stunted shrub; white and shining, its surface rippled by the wind, and traced at times with the strangely varied tracks of insects, birds, small creatures from the neighboring woods, turtles from the water, and, most numerous of all,

the mimic tracks made by light objects that are moved along by the wind, such a scene is in itself a study for a naturalist.

In some places, Lake Michigan is year by year building out the land with fresh deposits of sand, but oftener it is cutting it away with every storm. A reach of coast, extending perhaps a mile and a half southward from the foot of White Lake, is particularly interesting to one who wishes to study the structure of the country. Here, of late years, the lake has been eating away the land. The bluff facing the water is from fifty to one hundred and fifty feet high; sometimes its face is covered from top to bottom with earth that has slid down so as to conceal its structure, at other times this is all swept away and the strata are revealed. At such times an old surface-line of vegetable mold may be seen through the entire extent of the section at a height of from ten to twenty feet above the lake. Above this line all is sand, below it all is a heavy solid earth, of which clay forms the principal part. In the depressions of this line, where channels of drainage in this ancient line of surface may be supposed to be cut across, springs flow out. In one such depression there is a bed of peat, marking the site of an ancient swamp, and near each edge of this bed it is full of timber that has fallen into it when a swamp and there been preserved. Some of this wood seems to be but little changed, while other pieces have almost the color and texture of charcoal. Here we have found elm, oak, and black-ash, the species of which might be recognized as easily as if just from the forest. Some branches had been charred by fire, and altogether the deposit is exactly what we might expect to find in the edge of a Michigan swamp of the present day, with the difference that this has been compacted and hardened by time and pressure and drainage. The clay soil in which this old swamp was situated seems to underlie the sand everywhere in this region at varying depths, but on excavating to it we do not everywhere find the vegetable mold that here marks its surface. From these facts the conviction has grown that here in Western Michigan the condition of things has varied somewhat like this: First succeeding the introduction of the present order of things at the close of the last Glacial epoch, the entire country was at an elevation above Lake Michigan much greater than at present, great enough to drain the bottoms of all these river-lakes which, it should be noticed, are deepest near the great lake, and generally terminate in a swamp at their head, and each of which is elongated in the same general direction as the valley the foot of which it occupies. This condition of things lasted until the configuration of the land had become substantially what it is at present; then a subsidence took place, until all the lower levels of the country were beneath the waters of Lake Michigan. Again the country began to rise, and as the submerged lands were lifted above the water they were covered with sand, exactly as the lake now deposits sand on a retreating coast. When this uplifting reached such a degree that the action of the

waves was disturbed by the bottom near the edge of the deep water marking the ancient boundary of the lake, sand-bars would be deposited there as we find them, and these would stretch across the mouths of the submerged river-valleys, and on further uplifting they would separate the waters occupying them from those of the great lake, which, meanwhile, would go on adding more sand to them from without. This is the condition of things existing at present. The changes of level that have brought it about have not been uniform and constant; they may have consisted of a single sinking and rising, but more probably there were many. Even yet we see that the solid-seeming earth is sinking and swelling there in a most capricious manner. It is hard to tell to what the present movements are tending even—whether for a long period the land is to remain substantially at its present level, whether it is to rise until the river-lakes are drained and the Western Michigan lake-ports are left stranded inland, or whether the country is to be again submerged. We see, within the memory of those now living there, a variation of level to the extent of six feet at least, and in both directions. Forty years ago the land seems to have been at a higher level than it is at present, and to have continued so long enough to permit the growth of large trees on land since submerged. Then there was a subsidence to an extent of several feet, then an uplift until the waters were below their present level, and at last accounts another subsidence seemed to be in progress. Who can tell us its limits, either as to time of continuance, rapidity, or extent? What is the nature of this movement? There are difficulties in the way of accounting for it that would not exist if Lake Michigan were the ocean. A rising and falling of the land as a whole would include the bed of the lake, and would not produce these changes of relative level. To lift the bed of Lake Michigan, might pour out a part of its contents, and so cause an enormous increase in the volume of the St. Clair, Detroit, and St. Lawrence Rivers, with a corresponding diminution when a subsidence was taking place, the rivers rising as the lake was going down, and falling as the waters of the lake were rising; but this, we believe, has not taken place. Is it a shrinking and swelling of the upper strata of Western Michigan, leaving the deeper strata in which the bed of the lake rests comparatively undisturbed? Is it a rocking of the lake-bed from side to side, one part sinking as another rises? What is the extent of the country through which these movements are felt? These questions, and others relating to the matter, would seem to be of interest. Perhaps, if the Government would take the subject in hand and cause a record to be kept of the water-level at all light-houses and life-saving stations, a few years might throw light upon it.

SKETCH OF AUGUST WILHELM HOFMANN.

By EDWARD J. HALLOCK, Ph. D.

THE recent visit of this distinguished scholar and chemist to our city is worthy of more than a passing notice, and we would commemorate it in a feeble manner by placing before our readers a sketch and portrait of the man who has contributed so much to the advancement of science and of human progress.

August Wilhelm Hofmann was born in Giessen, April 8, 1818. After completing the usual gymnasium course, he entered the University of Giessen at the age of eighteen. Having acquired a taste for the modern languages during his travels in Italy and France, he at first took up the study of philology, to which he devoted himself assiduously for several years. To this we may undoubtedly attribute much of his power as a writer and speaker. At this time his father, who was an architect, was engaged on the plans for Liebig's new laboratory, and thus young Hofmann became acquainted with that famous chemist. His influence turned the whole course of Hofmann's life, for he at once took up the study of chemistry, and we next hear of him as the assistant of Liebig. He remained in this position until the spring of 1845, when he was appointed professor in Bonn, but he was not destined to remain long upon the Rhine, for, in the latter part of the same year, he was called to London and placed in charge of the newly established Royal College of Chemistry. Through the exertions of Professor Hofmann, and his popularity as a lecturer and teacher, this school soon acquired such a prominence that, in 1853, the Government united it with the Royal School of Mines. It was during this time that he made several of those important researches which have resulted in discoveries of the greatest importance. In addition to his other labors, he found time to deliver courses of lectures to workingmen, which were well attended, and to investigate various technical and sanitary questions upon which his opinion was sought. His success in solving difficult expert problems soon won for him an influential position in England. In 1856 he was appointed Warden of the English Mint, which position he continued to hold until he left England. He was made a fellow of the Royal Society in 1861, and ten years later was nominated President of the London Chemical Society. He served on the jury in the International Exhibitions held in London in 1851 and 1862. Among the important investigations of public interest was a chemical examination of the waters of London, and, with Professor Graham, an investigation of the bitter ales at a time when the brewers were suspected of using strychnine as an adulterant.

His early philological studies enabled him rapidly to master the intricacies of the English language, so that he became a fluent speaker and a correct writer in our tongue. Several of his works have appeared in English first, and subsequently been translated into German.

His reputation as one of the most successful teachers of chemistry of the present day brought him many offers from German governments, for at that time he stood almost alone as a teacher of organic chemistry according to modern ideas. In 1862 he was called to Bonn, where he undertook the building of a fine chemical laboratory, but he was not permitted to finish his undertaking, for in 1863 he was appointed the successor to Mitscherlich at the Frederick William University in Berlin.

His first work in Berlin likewise consisted in the planning, erecting, and equipping of a new chemical laboratory, which was opened in 1868. It consists of a substantial brick edifice, built in the form of a hollow square, in the center of which is a large, airy, and well-lighted lecture-room, capable of seating about two hundred students. Two large courts, one on each side of the lecture-room, afford abundant light to the various work-rooms, laboratories, and smaller lecture-rooms. The entire structure occupies a lot of ground one hundred and forty by one hundred and sixty-five feet on Georgen Strasse, with an extension seventy feet wide running through to the Dorothean Strasse. On the latter are the library and residence of the professor. The situation is a central one, near the principal station of the elevated railroad (Stadtbahn), and but five minutes' walk from the university building on Unter den Linden.

Professor Hofmann's lectures are illustrated by very elaborate experiments, and the fundamental laws of the science are demonstrated by means of apparatus devised by himself for this special purpose. No other living chemist, Bunsen perhaps excepted, has invented so many new and useful forms of lecture apparatus as Hofmann. Besides his earlier papers on this subject, a season rarely passes, even now, without some new contribution to this kind of literature from his fertile pen. His lectures are so interesting, his manner so animated, that his lecture-room is thronged with students from all parts of the globe.

Soon after his removal to Berlin, Professor Hofmann founded the German Chemical Society, of which he has several times been president, and the growth of which has been largely due to his efforts. Although German in name and in language, it numbers among its twenty-seven hundred members persons of every nation where chemistry is cultivated, and its proceedings are the chief means of communication between a large portion of the chemists of this and other countries. The number of original papers published by it is larger than that of the English, French, and American chemical societies combined.

Although Hofmann excels as a lecturer and teacher, his reputation rests chiefly on his valuable and numerous contributions to the science of organic chemistry, foremost among which are his investigations on the coal-tar colors.

He first began the study of the bases in coal-tar under the direction of Liebig, and in 1843 we find him publishing his first original paper on this subject. One of these bases, then known as "cyanol," attracted his special attention, and by working over half a ton of coal-tar he succeeded in obtaining this rare base in sufficient quantity to investigate its properties, which he found to be the same as those of "benzidam." Further investigation also enabled him to prove that "aniline," the name then given to a substance that had only been obtained from indigo by distillation, was identical with both cyanol and benzidam. Here, then, were three sources for obtaining this rare material. Evidently there could not be much of it in coal-tar, when only three pounds could be separated from half a ton of tar; indigo, too, was an expensive source; hence it was a fortunate circumstance that Zinin had discovered another method of making it, and that too from a far more abundant constituent of coal-tar, namely, benzol; it is from that all the aniline of the present day is prepared.

Hofmann, it is said, noticed that aniline gave rise, under certain conditions, to the production of a red color, but he failed to publish the fact, and to Perkin belongs the credit of having discovered the first aniline dye—mauvine. This took place in 1856, and two years later Hofmann discovered a red dye, then called Hofmann's red, which was formed by the action of chloride of carbon upon aniline. Aniline was beginning to attract the attention of manufacturers as well as of chemists, and many different methods were devised for making what seemed to be the same substance, a fine red dye variously known as magenta, solferino, fuchsine, and aniline red. Hofmann undertook a careful investigation of the dye, which resulted in his discovery of the surprising fact that the red dye was in reality the salt of an organic base, like an alkaloid, and that this base, to which he gave the name of "rosaniline," was *colorless*. From this base he prepared another which he called "leucaniline" by reducing it with zinc. Turning his attention to the blues, greens, and purples, he found them to be derivatives from this same base, but of more complex construction. The importance of these investigations can scarcely be overestimated. The production of dyes from aniline was no longer a matter of blind experimentation; empirical methods gave place to scientific ones, and the process of making dyes has gone on to the present day nearly in the same direction. One of the earliest practical results of this discovery was the invention of a series of most beautiful purples which still bear the name of Hofmann. Like Leverrier's discovery of Neptune, their elements had been calculated beforehand, their existence foretold, and they needed only to be made.

Before taking up the investigation of the aniline dyes, Hofmann had been engaged in a line of research, which, though apparently of mere theoretical interest, had especially fitted him for this work, namely, the study of organic ammonias, or amines. In 1849–'50 Hofmann made the discovery that when ammonia was acted upon by certain alcoholic iodides, such as methyl iodide, one, two, or three of the hydrogen-atoms of the ammonia could be replaced by the alcoholic radical. In this way he prepared trimethylamine, a substance which he subsequently found to exist ready formed in herring-pickle, and from which it is still obtained for medicinal purposes. For his investigations on the molecular constitution of the organic bases, he was awarded the Royal Medal in 1854, and in 1867 he received the great prize of the World's Fair at Paris.

Engaged in studies of this sort, the resemblances between aniline oil and ordinary ammonia, and more especially between their respective salts, could not escape his notice. Each contains one atom of nitrogen; the substitution of a certain group of atoms known as the phenyl group for one of hydrogen will convert ammonia into aniline. In the more complex molecule of rosaniline, with its three atoms of nitrogen, he naturally sought for a triple ammonia, but he found the phenyl group alone incompetent to form this base, which led to his discovery of the very important fact that no dyes can be made from *pure* aniline, an admixture of its homologue, toluidine, being essential to the production of the rosaniline and its derivatives.

Organic bases, containing other elements than nitrogen, have also attracted his attention, and through his labors much has been added to our knowledge of the "phosphines," phosphonium, etc.

Another class of subjects, to which Hofmann has devoted much attention, includes the mustard-oils, both natural and artificial, and the sulpho-cyanides of organic bodies. These researches have resulted in the artificial production or synthesis of many pungent oils and ethers. He has also fearlessly attacked the cyanides themselves, and succeeded in producing some new organic compounds that fairly rival Bunsen's well-known cacodyle in their repulsive odors.

Among the analytical processes introduced by Dr. Hofmann are several of importance, including the separations of arsenic from antimony, and of copper from cadmium, and the detection and estimation of carbon disulphide. Hofmann's method of determining the specific gravity of vapors is as remarkable for its simplicity as for its accuracy.

Although a fertile writer, Professor Hofmann is not given to writing books. He has, however, contributed a great many original papers to various chemical journals, of which the "Journal of the London Chemical Society" contains more than ninety, and nearly two hundred more are to be found in the "Berichte" of the Berlin Chemical Society. He was for a time one of the editors of Fowne's "Manual of Chemis-

try," and since 1874 has also been one of the editors of the "Annalen der Chemie und Pharmacie," established by Liebig.

A portion of the course of lectures upon inorganic chemistry, which he had delivered so acceptably before the Royal College of Chemistry in London, was published in book form in 1866, under the title of "Lectures on Chemistry." It was soon after translated into German, and has passed through several editions under the more appropriate title of an "Introduction to Modern Chemistry." We know of no other book in any language on this trite subject that exhibits so much originality of treatment, or that is more pleasing in style, convincing in its demonstrations, and logical in method. Taken in connection with the ingenious apparatus therein described, it has had avery beneficial effect upon the methods of teaching chemistry.

The substance of his lectures upon organic chemistry was published in 1872 by one of his former assistants, Dr. A. Pinner, and during the past year it has been translated into English by Professor P. T. Austen, one of his American pupils.

Hofmann's "Life-Work of Liebig" is a worthy monument to the great chemist; while his biography of the great French chemist, Jean Baptiste André Dumas, in the "Nature" series of scientific worthies, is a charming specimen of English composition. His memorials of deceased scientists are worthy of more than passing mention. Among those whose memories have been perpetuated by his pen are Thomas Graham, Gustav Magnus, and last of all Friedrich Wöhler.

Several of his addresses delivered upon special occasions have been published, among which are two academical orations delivered recently in Berlin, which have appeared under the title of "Chemische Erinnerungen aus der Berliner Vergangenheit." His inaugural address upon assuming the rectorship of the Berlin University has provoked some discussion, owing to the position taken in regard to classical studies, and has already been referred to in our pages. His largest and most important work is his "Report on the Development of Chemical Industries," which first appeared in 1875–'76.

CORRESPONDENCE.

OLD STUMP-WELLS IN THE MISSISSIPPI "BOTTOM."

Messrs. Editors:

IT is a fact well known to all who have made any study of the "Bottom," or alluvial plain, formed during the lapse of ages by the great Mississippi River, that the river channel, or bed, is forever shifting, and in its mighty contortions it has moved laterally eastward and westward over vast spaces. Many of the abandoned channels are now curved lakes, with no connection with the river; others, connected with it more or less during floods, are called "old rivers." So thoroughly the river does its work in forming the land that, besides these crescent-shaped lakes and old rivers, there is little in view to indicate where the bed of the river lay one hundred or one thousand years ago. When the river changes its channel, by suddenly or gradually cutting through a point of land, or when one chute of an island is closed by a bar, a lake or an old river is formed; but, when the river shifts its position, by continued abrasion on one side, and by corresponding deposit of sediment on the other, the latter slowly but steadily rises to the average height of the neighboring land, and in a few years is covered by a heavy forest-growth, and there is no visible sign left to show that it has not been thus since the creation, or at least since the Gulf of Mexico deserted that particular point on its everlasting retreat southward.

The tract of land on which I reside, and which I have owned for more than forty years, was washed, up to about the year 1855, by the main body of the Mississippi River, swinging around the western side of a plano-convex-shaped island; at that period three fourths of all the water of the river passed my door, but about that time, the exact year I do not remember, the channel began to change, and in a very few years the main body of water was, and has since then been, running down the plano and eastward side of the island, and the head of the western chute is largely obstructed by bars. Whether the bars formed first, and forced the channel eastward, or whether the change of the channel caused the bars to form, has not, so far as I know, been satisfactorily answered. At all events, my land now lies on an "old river," which is never entirely dry, although often very nearly so, and the growing obstructions threaten to cut me off, at no distant day, from outside communication, at least by water, except at very high stages. I will add, in passing, that it is in contemplation by the National River Improvement Commission (which is spending millions in the interest of navigation, with no especial thought as to riparian interests) to hurry up this consummation by piling, willow-mattressing, etc., so as to force the entire body of water, even in its highest stages, through the eastern or shorter chute.

In addition to being located on an "old river," my land lies, as I believe, just where a river-formed lake existed at a remote period, but which has in process of time, long before memory goes, been filled up by deposits from overflows, until now it is somewhat higher than the general level of the neighboring sections, and I will give my reasons for so thinking as briefly as I can. At certain periods of the year, as there are no small running streams in this section, cattle suffer from thirst, although the great river runs by our doors, for then the stream is low, and the banks are either precipitous, or, when sloping, terminate in a quicksand, in which many uncared-for cattle are lost every year; hence the necessity for abundant wells and cisterns.

Seeing some water standing in an old, hollow cypress-stump, about four fee tin diameter, the surface of which water was at least fifteen feet above the surface of the river at the time, I was curious enough to investigate the matter. An outside rim of the stump, about four inches in thickness, remained sound, but the interior portion (all except a hollow of about a foot in diameter, down which I had observed the water) was composed of dry-rotted wood, still clinging closely in place. I had the rotted portion taken out down to the surface of the water, and the water pumped out, finding the reservoir to extend down sixteen feet. In about six hours the water had returned to its former level. Pumping it out again, I had the rotten wood removed; this was done with very little trouble. With a little more digging, and removing the old wood, which had previously fallen to the bottom, I discovered where the main roots of the tree started at a distance of about seventeen feet below the surface of the ground, plainly showing that, when the tree first sprang from the seed, the surface of the ground was many feet lower than at present. After thoroughly cleaning out the well, I permitted the water again to rise, and found it cool and wholesome, with a slightly brackish taste, but not at all offensive.

Subsequent investigation showed me that every hollow cypress-stump (and there are a

large number of them) on my place is a natural well, but varying in depth, proving that the ground on which these trees sprouted was not level, or at least that the level was changed from time to time. I have one of these wells in my stable-yard; it is about four feet in diameter and nine feet in depth. I cut the stump off level with the ground, floored it over, and placed a pump in it, and in the driest seasons it furnishes abundant water for my stock. I have about fifteen dug wells on my place, all within the space of two square miles; the depth of the water-surface in these varies from eight to fifteen feet. A large curbed well stands in my gin-house, within twenty feet of the bank of the river, and to-day the water stands in this well at least fifteen above the surface of the stream, and is in no manner affected by its rise or fall. It would not be difficult to form a reasonable theory to account for the deeply-rooted cypresses, but the formation and existence of the wells require the presumption of an enormous deposit of clay, and to account for the presence of the latter is the difficulty. The Mississippi brings down in suspension a comparatively small portion of argillaceous material, but it is certainly here in a solid stratum, and it came at a period subsequent to the sprouting of the old cypress-trees, for it is highly improbable that a tree should send down a tap-root eighteen feet, and then spread out its lateral supports. The cypresses, forty years old, make no such indications, but have their radical processes corresponding with those of the other trees of the forest.

JAMES B. CRAIGHEAD.

NODENA, ARKANSAS, *August* 1, 1883.

WORK OF SHOD AND UNSHOD HORSES.

Messrs. Editors:

IN the February number of your magazine appears an article, by Arthur F. Astley, on the "Working Capacity of Unshod Horses," in which the writer states, "*In New Mexico, horses are ridden barefoot forty miles day after day, and perhaps twenty miles of this will be over a rough mountain-track.*" Now, I have served with my regiment in New Mexico for several years, most of the time as post-quartermaster, having large numbers of both horses and mules under my charge. While it is true that most horses are ridden unshod by the natives in the *valleys*, where the roads are sandy and soft, it should be borne in mind that even there the majority do so simply because they are too poor to have their horses shod; but, when it comes to traveling over rough mountain-tracks, the writer's statement is simply absurd. The Indians (Apaches) understand the inability of unshod horses to travel over mountain-trails so well, that they cover their horses' feet with raw-hide bags, and, when the latter wear out, the horses soon become disabled, and I have frequently found Indian horses abandoned on the trail, with their hoofs bleeding and worn, and the poor animals in a most pitiful plight. Again, when Indians are enlisted as scouts, they furnish their own mount, and, when reaching the post, they always request to have their horses shod. There can be no question that a *properly*-shod horse has a superior working capacity, but I confess that most shoeing, from the ignorance of the average farrier, is simply a process of torture and violation of nature, and crippled horses are the result. Most farriers place the horse upon an iron tripod, the weight of the animal resting entirely upon three points of the foot, and those *not* the parts intended to bear the shock of travel, or to sustain his weight. The position of the frog becomes one of hopeless inaction, and the motion of the unsupported bones within the hoof produces inflammation at the points of extreme pressure. But I did not intend to write an essay on horse-shoeing.

Respectfully, yours,

THEODORE SMITH,

Lieutenant, United States Army.

WASHINGTON, D. C., *February* 17, 1884.

AMERICAN LOESS-DEPOSITS.

Messrs. Editors:

I HAVE just read Mr. D. W. Williams's interesting article in your December issue on "The Loess-Deposits of Northern China," and am rather surprised to find no allusion therein, by way of comparison or otherwise, to the very extensive loess-deposits of the United States—especially, since it was here, in the valley of the Mississippi, that this peculiar soil was first studied and named *loess* by Sir Charles Lyell, during his second visit to the United States in 1846.

Mr. Williams speaks of the loess-beds of China as among the most remarkable and important geological phenomena hitherto brought to light in Middle Asia, and says "the term *loess* has been used to designate a tertiary deposit appearing in the Rhine Valley, along the Danube, and in several isolated sections of Europe," etc. But the loess-beds of Nebraska, alone, exceed in extent of area those of all Europe combined; and their aggregate extent within the States of Nebraska and Minnesota and the Territory of Dakota falls but little, if any, below that of the loess-beds proper of Northern China. It is believed that the total extent in square miles of this deposit within the States and Territories drained by the Missouri and Mississippi Rivers exceeds that within the Chinese provinces drained by the Yellow, the Wei, and the northern tributaries of the Yangtse.

Mr. Williams does not give any analyses

of the Chinese loess, but it appears to be not essentially unlike that of the Rhine, which, as analyzed by Bischoff, contains a larger proportion of alumina than the samples hitherto analyzed from Nebraska. Bischoff found in four analyses of Rhine loess:

	NUMBER OF ANALYSIS.			
	1.	2.	3.	4.
Silicic acid	58·97	79·53	78·61	62·43
Alumina	9·97	18·45	15·26	7·51
Peroxide of iron	4·25	4·81		5·14
Lime	0·02	0·02	....	....
Magnesia	0·04	0·06	0·09	0·21
Potash	0·11	1·05	3·31	1·75
Soda	0·84	1·14		
Carbonate of lime	20·16	....	....	11·63
Carbonate of magnesia	4·21	....	....	3·02
Loss by ignition	1·37	....	1·89	2·31

Dr. Hayden, in his "Final Report on the Geology of Nebraska," gives, on page 12, two analyses of the loess from Hannibal, Missouri, made by Dr. Lytton, as follows: in one hundred parts, there were of—

	No. 1.	No. 2.
Silica	76·98	77·02
Alumina and peroxide of iron	11·54	12·10
Lime	3·87	3·25
Magnesia	1·68	1·63
Carbonic acid	undetermin'd	2·83
Water	2·01	2·43
Total	96·17	99·26

Dr. Aughey, in his "Report on the Superficial Deposits of Nebraska" (United States Geological Survey, 1874), gives the analyses of five samples of the Nebraska loess taken from widely-separated sections, showing the wonderful homogeneity of the deposit over the large area which it covers in that State—estimated at not less than fifty-eight thousand square miles. His analyses are as follows:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Insoluble (silicious) matter	81·82	81·83	81·85	81·80	81·82
Ferric oxide	3·86	3·87	3·83	3·85	3·86
Alumina	·75	·75	·74	·73	·74
Lime, carbonate	6·07	6·06	6·03	6·05	6·09
Lime, phosph'te	3·58	3·59	3·58	3·57	3·59
Magnesia, carbonate	1·29	1·28	1·31	1·31	1·29
Potassa	·27	·29	·35	·34	·32
Soda	·15	·16	·14	·16	·16
Organic matter	1·07	1·06	1·05	1·06	1·06
Moisture	1·09	1·08	1·09	1·08	1·09
Loss in analysis	·59	·54	·58	·55	·47
Total	100·00	100·00	100·00	100·00	100·00

It will be seen from these several analyses that the loess of the Rhine and that of the Republican and the upper and lower Missouri are not chemically dissimilar. The latter is thoroughly homogeneous and of uniform color from whatever depth taken. Dr. Aughey says: "I have compared many specimens taken three hundred miles apart, and from the top and bottom of the deposits, and no difference could be detected by the eye, or by chemical analysis. Over eighty per cent of this deposit is finely-comminuted silica. . . . So fine, indeed, are the particles of silica that its true character can alone be detected by analysis or under the microscope." The tendency, noted by Mr. Williams, in the Chinese loess to crystallize spontaneously, and form the cylindrical and spherical concretions which the Chinese call "ginger-stones," is also noticeable over all the loess-regions of the West. Wherever the sod is broken or the earth freshly disturbed from any cause, whether by the plow, or "prairie-dogs," these "ginger-stones" literally cover the ground. This feature is presumably due to the richness of the soil in the phosphates and carbonates of lime, which constitute about one tenth of the entire mass.

In their structural as well as chemical characteristics our Western loess-beds seem to be identical with those of China. They present, also, the same striking peculiarities of landscape-contour, erosion-products, and surpassing fertility, so well described by Mr. Williams. The unique and often exceedingly fantastic forms assumed by the loess-bluffs wherever they have been subject to erosion, as along the Missouri and lower Platte, have long excited the curiosity of tourists. Indeed, so quaint and striking are many of these natural carvings—now stately and now grotesque—that it is not easy on first acquaintance to accept them as the products of natural causes merely, and not rather as the gigantic labors of past generations. In point of architectural adaptability, too, these Nebraska bluffs are the fellows of their Chinese congeners, and fulfill the same generous function of affording cheap and healthful domiciles to whomsoever will carve out their homes in them. Many are the happy and well-to-do families, scattered over these fertile regions—especially in Nebraska, Dakota, and Southwestern Minnesota—who have known no other home since "coming West" than the smoothly-hewed walls of the facile loess. Nor, for ends of comfort, cleanliness, or health, do they need to seek better homes—only at the behest of taste or fashion; though, as wealth increases, the American squatter, unlike the Mongolian, soon builds for himself a more pretentious dwelling, and converts his old home into a stable or piggery. I have sometimes had occasion to seek shelter from a storm in one of these "dug-outs," and in traveling have often spent a night in them, and can testify as to the excellent quarters they afford for both man and beast. Like the "adobe" houses of the Mexicans and Pueblo Indians, they

are cool in summer and warm in winter, but are superior to "adobe" dwellings in point of dryness and cleanliness. This superiority is due to the fact that wherever the soil is smoothly cut the slight chemical union, which speedily takes place under the influence of the atmosphere between the silica and the carbonate of lime, coats the surface as if with a light washing of cement, and so prevents crumbling. One may note spade-marks as clean-cut and fresh-looking as if newly made on the walls or ceiling of "dug-outs" that have been occupied for years. When the threatened (?) "Mongolian invasion" comes, what hosts of happy Celestials will find here congenial homes! And if, for their better contentment, they rechristen the Missouri the Yellow River, it will be no serious misnomer.

In point of fertility our Western loess-beds are the counterpart of those described by Mr. Williams, except that they do not seem to suffer equally in seasons of drought. The greater depth of the Nebraska deposits —exceeding in many places two hundred feet—and, possibly, their more perfect capillary structure, may explain this difference.

As to the origin of the loess-beds of the United States, the belief of Drs. Hayden, Aughey, and others that they are lacustrine deposits has been hitherto accepted. But it is curious to note how many of their peculiar characteristics are explained, and their general features harmonized with the geological and meteorological phenomena of the great region lying between them and the summit of the Rocky Mountains, by the hypothesis that they are subaërial rather than subaqueous deposits. Nearly all the arguments adduced by Baron von Richthofen in support of his theory of the origin of the loess-beds of Asia may be adduced with equal force, *mutatis mutandis*, in support of a like theory here. Of more than one hundred and twenty species of shells found and identified in the loess-deposits of Nebraska, as given by Dr. Aughey on pages 267 and 268 of "United States Geological Report" for 1874, it will be seen that a large proportion are land-shells. And it appears from the same "Report" that, while the deposits are rich in the remains of land-animals, no considerable number of aquatic species have ever been identified.

Dr. Aughey says, page 254: "Occasionally I have found the teeth and a stray bone of a fish, but have not been able to identify any species. The remains of rabbits, gophers, otters, beavers, squirrels, deer, elk, and buffalo are frequently found. Through the entire extent of these deposits are many remains of mastodons and elephants." To one who has ever encountered a dust-storm on the great plains west of these deposits, when the landscape to either horizon is obscured with flying clouds of powdery dust, like drifting fog, and has noted the almost continuous belt of sand-hills extending from Western Kansas through Eastern Colorado and Wyoming and Western Nebraska, evidently formed by these high winds, whose prevailing direction is always eastward, and marking the deposit of the heavier particles dropped from the flying mass of dust-freight which they had gathered in their fury from the arid foot-hills and high plains still farther westward, the theory of Von Richthofen commends itself with peculiar force. And if a period of still greater aridity be conceived of, before these high regions, the American analogues of the Asiatic steppes, had received their present scant protection of stunted grasses, the conviction arises that, even assuming the volume and velocity of the wind to have been no greater then than now, its prevailing direction being the same, our loess-deposits of the Northwest, like those of China, may be accounted for, both as to their origin and chief peculiarities, by reference to known causes still existing, whose action has been, indeed, greatly modified but not wholly suspended; and without recourse, necessarily, to the lacustrine hypothesis.

WILLIAM T. HOLT.

DENVER, COLORADO, *January* 4, 1884.

EDITOR'S TABLE.

THE EDINBURGH REVIEW ON THE SPENCERIAN PHILOSOPHY.

THERE is obviously a decline in the influence of malign criticism in recent times. Even the savage "quarterly reviewer" has lost many of the terrors with which he used to be invested. An excellent example of this is afforded by the history of Spencer's "Synthetic Philosophy." It has been tempting game for the critical sports, and they have pursued it unwearyingly. It had but few friends and multitudes of enemies. A new departure in philosophy, it incurred the hostility of the devotees of all old philosophies. Dealing with the larger aspects of science, it kindled the jealousy of narrow-minded scientific

specialists. Antagonizing established political opinion and cherished religious beliefs, it provoked the wrath of all who rest contented in tradition. Appearing in successive parts and volumes for twenty-five years, it was constantly before the public, and has been all that time subject to a degree of abuse, ridicule, and detraction, which is quite without parallel in the past history of such enterprises.

And yet during all that time Spencer's system of thought has increased in recognition, appreciation, and power over the mind of the age. Its doctrines permeate our serious literature, as is widely shown by the periodicals; many books are written for and against them; and their author stands to-day the representative man of the most influential and growing school of thought in modern times. This view is further verified by the increasing public demand for his works, more of the solid volumes of the "Synthetic Philosophy" having been called for during the last twelvemonth than in any former year. The inexorable critical resistance Spencer's works have met with has no doubt hindered their spread, but it has failed to arrest them, and has only served to test and demonstrate the inherent strength of his systematic work.

And now the sluggish old "Edinburgh Review" has at last awakened, girded itself up, and entered the lists against Mr. Spencer. The current number contains an article entitled "The Spencerian Philosophy," to which we here call attention, not because it has the slightest value as a contribution to the subject, but because we may gather from it an instructive lesson regarding the decline of the influence of vindictive criticism. It happens that the "Edinburgh Review" has a history in this matter. This is not the first time it has practiced its bludgeon upon the representatives of advancing knowledge. Let us, therefore, first notice its early record in relation to one of the most important steps in the progress of modern science—the establishment of "the undulatory theory of light" by Dr. Thomas Young. We give the "Review" full credit for consistency in an unprincipled course; the instinctive meanness of its infancy, long since execrated by the world, is not in the least abated in its senile dotage.

The "Novum Organon Renovatum" of Dr. William Whewell is an able work devoted to the philosophy of the inductive sciences, of which the same author is also the eminent historian. Dr. Whewell has selected the two most conspicuous examples of comprehensive and valid induction afforded by physical science, and by means of charts he has illustrated in a very striking way the extent of the observed and experimental facts, and the minor inductions, that are brought into unity by all-embracing theories. The first chart is an "Inductive Table of Astronomy," and it shows in a very interesting manner how completely astronomical phenomena are explained and brought into harmony by "the theory of universal gravitation." The second chart is "An Inductive Table of Optics," and in a corresponding way it exemplifies the elucidation of luminous phenomena, and the explication of general optical effects which result from "the undulatory theory of light." Whatever may be the imperfection of these theories, they have fulfilled the purposes of giving rational interpretation to wide ranges of natural phenomena, and of guiding the human mind in the pathway of new discovery by the power of prediction that they have conferred, and the two theories stand together as eminent triumphs of physical reasoning. The name of Newton will be forever associated with the law of universal gravitation, and in the same way Dr. Thomas Young will be immortal as the man whose genius established the undulatory theory of light, and who has hence been very appro-

priately designated as the Newton of the science of optics.

The optical theory which reigned in the scientific world until the beginning of the present century was known as the theory of emission, which assumed that all luminous effects are due to the darting, rebounding, and deflecting of some kind of material corpuscles or particles. The idea of vibratory or undulatory action as the cause of light was early broached by Huygens and maintained later by Euler, but was generally regarded as a crude speculation without scientific value. Dr. Young, devoting his great powers to optical research, soon perceived that the evidence was decisive in favor of the undulatory view; and, in the case of the interference of light, he proved that it affords a complete interpretation of the effects where the emission theory wholly breaks down. He developed his ideas in elaborate papers published in the "Proceedings of the Royal Society," and gave them mature expression in the Bakerian Lecture of 1802. It was at once seen by a few discerning scientific men that the old controversy between the theories of light was virtually brought to an end. But the old explanation, long accepted, and sanctioned by the great authority of Newton, was, of course, still supreme, while the new explanation had its way to make in scientific circles and in the general mind.

The "Edinburgh Review" now appears upon the scene. This quarterly had just been established, and was supported by a brilliant corps of writers who attracted wide attention, and gave to the periodical an extensive and powerful influence. Henry Brougham, afterward Lord Chancellor of England, was among its founders, and was one of its most versatile and effective writers, and he had himself dabbled somewhat in optical science. He reviewed Young's Bakerian Lecture on "The Theory of Light and Colors," which appeared in the "Philosophical Transactions," and the article was published in the first volume of the new Edinburgh quarterly issued in 1803. It was an insulting and malignant attack upon Dr. Young, whom he ridiculed in the coarsest manner. Mr. Brougham characterized the Bakerian Lecture as worthless, and bitterly denounced the authorities of the Royal Society for degrading science by admitting such foolish speculations into their published proceedings. The event is so memorable that we shall be excused for making some quotations from the article. It opens with these words: "*As this paper contains nothing which deserves the name either of experiment or discovery, and as it is in fact destitute of every species of merit,* we should have allowed it to pass among the multitude of those articles which must always find admittance into the collections of a society which is pledged to publish two or three volumes every year. . . .

"We wish to raise our feeble voice against innovations that can have no other effect than to check the progress of Science, and renew all those wild phantoms of the imagination which Bacon and Newton put to flight from her temple. . . .

"It is difficult to argue with an author whose mind is filled with a medium of so fickle a vibratory nature. Were we to take the trouble to refute him, he might tell us, 'My opinion is changed, and I have abandoned that hypothesis, but here is another for you.' . . .

"We demand if the world of science, which Newton once illuminated, is to be as changeable in its modes as the world of taste, which is directed by the will of a silly woman or a pampered fop. Has the Royal Society degraded its publications into new and fashionable theories for the ladies who attend the Royal Institution? *Proh pudor!* Let the professor continue to amuse his audience with an endless variety of

such harmless trifles; but in the name of Science let them not find admittance into that honorable repository which contains the works of Newton, Boyle, Cavendish, and Herschel. . . .

"From such a dull invention nothing can be expected. It only removes all the difficulties under which the theory of light labored to the theory of this new medium which assumes its place. It is a change of name; *it teaches no truth, reconciles no contradictions, arranges no anomalous facts, suggests no new experiments, and leads to no new inquiries.* It has not even the pitiful merit of affording an agreeable play of the fancy. *It is infinitely more useless and less ingenious than the Indian theory of the elephant and the tortoise.* We have a right to demand that the hypothesis shall be so consistent with itself and so applicable to the facts as not to require perpetual mending and patching—that the child which we stoop to play with shall be tolerably healthy, and not of the puny, sickly nature of Dr. Young's productions which have scarcely *stamina* to subsist until the fruitful parent has furnished us with a new litter; to make way for which, he knocks on the head or more barbarously exposes the first."

This is certainly poor stuff, read in the light of subsequent history. Of the man so shamefully vilified by a reckless critic, Professor Helmholtz thus speaks: "His was one of the most profound minds that the world has ever seen; but he had the misfortune to be too much in advance of his age. He excited the wonder of his contemporaries, who, however, were unable to follow him to the heights at which his daring intellect was accustomed to soar. His most important ideas lay, therefore, buried and forgotten in the folios of the Royal Society until a new generation gradually and painfully made the same discoveries, and proved the exactness of his assertions and the truth of his demonstrations."

Nevertheless, the "Edinburgh Review" had power to extinguish the influence of this extraordinary genius, and it was the article from which we have quoted that did the work. Rubbish as it now appears, it was accepted as truth, and the effect was to close the channels of reply to Dr. Young, and push him into obscurity as nothing better than a shallow pretender. As Professor Tyndall remarks: "For twenty years this man of genius was quenched—hidden from the appreciative intellect of his countrymen—deemed, in fact, a dreamer, through the vigorous audacity of a writer who had then possession of the public ear, and who, in the 'Edinburgh Review,' poured ridicule upon Young and his speculations."

Such was the power of base-minded criticism at the beginning of the century; and such the first great exploit of the "Edinburgh Review" in relation to the progress of scientific thought.

Eighty years have since passed away, but the old Scotch quarterly has learned nothing. Oblivious of the great changes that have taken place in the world of thought, it undertakes to repeat upon Herbert Spencer the tactics which proved so effectual in suppressing the greatest scientific man of the opening century. It will fail, and not only this, but the absurd anomaly of its action will be certain to defeat the end it proposes to accomplish. There could hardly be a greater compliment to the work of Spencer than that the "Edinburgh Review" should at this time have printed so incompetent and ridiculous an assault upon it.

The reviewer entitles his article "The Spencerian Philosophy," but it is false to its title in that it makes not the slightest attempt to deal with that philosophy. It shows no appreciation of it, and conveys no shadow of an idea of its real character. The discussion is confined to "First Principles," the opening volume of the philosophical sys-

tem, which was published twenty-two years ago, and the article is characterized throughout by the most inexcusable ignorance of the subjects considered. It is spiteful, contemptuous, and flippant in spirit, vicious in misrepresentation, and mean in its covert insinuations and outright imputations. Brougham's assault upon Young is its model, and the phraseology of disparagement is almost identical in the two papers, as we illustrate by italicized passages. The reviewer says of Spencer: "*He has not ascertained or discovered a single new fact, nor put any old ones together in such a way as to justify any new inference as to their causes*, either immediate or ultimate. He has only applied new and fanciful terms to the collections he has made." And this is the way he sums the matter up: "This is nothing but a philosophy of epithets and phrases introduced and carried on with an unrivaled solemnity, and affectation of precision of style concealing the loosest reasoning, and the haziest indefiniteness on every point except the bare dogmatic negation of any 'knowable' or knowing author of the universe; which, of course, is the reason why this absurd pretense of a philosophy has obtained the admiration of a multitude of people who will swallow any camel that pretends *to carry the world standing on the tortoise that stands on nothing*, provided only it has been generated by a man out of his own brains, and asserted in imposing language with sufficient confidence." The philosophy of the universe, it may be remarked, which is tacitly held by the writer, is simply mathematics and physics *plus* Scotch orthodoxy.

We have no space to go into particulars in regard to this performance, but may give one illustration of its looseness and lack of decent regard for truth. Its fragmentary quotations are made in the most slovenly manner, and mixed up with the language of the writer so as to convey his own perverted meaning; and, as if conscious of this, he seems to think it necessary to make at least one fair extract. So he says: "This time we will not omit a word for brevity. We ought to give at least one specimen of Mr. Spencer's most careful and precise style unreduced." Then follows an extract of eighteen lines, and, if the reader will believe it, the passage *was reduced by the dropping of whole clauses*, which were not only significant, but made the entire statement unintelligible. And if the reader hesitates to believe this on *our* authority, as too improbable a thing, then let us say that Mr. Proctor has exposed it in his London journal, and convicted the reviewer of mutilation by publishing the extract, with the omissions bracketed.

The "Edinburgh Review" will not succeed at this late day in the revival of its old tactics. Its "slashing" article will be rated at its true worthlessness because there are now multitudes who have some intelligent understanding of the Spencerian philosophy, even if the chosen reviewer knows nothing about it, cares nothing about it, and only takes it up to make a sensational caricature of it. In confirmation of this, we quote a passage from a recent letter of Mr. Richard A. Proctor to the "New York Tribune":

> The "Edinburgh Review" makes a savage assault on Herbert Spencer this quarter, in an article written in a style so familiar that it might as well have been signed. Those who admire the work which has already been achieved and is in progress of achievement by the leading philosopher of the century, will be scarcely less pained by this unfair and acrimonious attack than those who have a regard for the reputation of Sir Edmund Beckett. Sir Edmund has attacked the Bacon of this day in terms that would be hardly appropriate if applied to one of those absurd persons who go about with theories that the earth is flat, the law of gravity a gigantic blunder, and the squaring of the circle child's play. Belonging myself to both categories above mentioned, I am doubly grieved. I value Sir Edmund Beckett as a kind personal friend, a masterly reasoner within certain

lines, and one of the most skillful advocates, whether of a good or of a mistaken cause, that I have ever met. Herbert Spencer I esteem, I may almost say reverence, as the teacher of the soundest system of philosophy the world has yet, in my judgment, known. That a man whose researches reach so widely should at times fall into error in matters of detail may be readily admitted. Only a few weeks ago I pointed out in the pages of my weekly journal, "Knowledge," what *I* hold to be an entirely erroneous view of Herbert Spencer's respecting the probable origin of the system of asteroids. Yet even in matters of detail belonging to the work of specialists he has been singularly clear-sighted. He first pointed out the fallacies underlying the long-accepted teaching respecting the stellar system, star-clusters, nebulæ, etc., which men like Arago and Humboldt had dealt with without detecting error. In every department of science, in fact, though a specialist in none, Herbert Spencer has left his mark.

The attack in the "Edinburgh Review" leaves Spencer's fame untouched. It is evident in every line of this sour production that the enmity which Sir Edmund Beckett has always felt and expressed toward the teachings of the school of which Spencer has been the Bacon, the Darwin, and the Newton, has made it impossible for him to read with even average attention the work which he pretends to criticise. He has not caught the veriest glimmer of a notion of Mr. Spencer's real meaning. From the only passage which he claims to quote entire he has allowed several important words to drop—by accident doubtless, but yet not by mere accident in transcribing what he had already carefully read and understood; for the reasoning which follows falls to the ground so soon as the omitted words are restored.

Let one example suffice to show how utterly Sir Edmund Beckett either has missed or misrepresents the meaning of the famous contemporary whom he assaults. Herbert Spencer, speaking of the Great First Cause, transcending all laws, Absolute, Unconditional, says that we only perceive It, can only recognize It, by the persistence of force which, as it were, symbolizes It. Sir Edmund regards this as equivalent to saying that the Great First Cause *is* nothing else but persistent Force. Beckett rebukes Spencer for speaking of the "laws of motion" as the results of experience, saying that Newton regarded them as self-evident. He must have forgotten Newton's "Principia," where these laws are presented by Newton as now spoken by Spencer.

LITERARY NOTICES.

HAND-BOOK OF SANITARY INFORMATION FOR HOUSEHOLDERS, containing Facts and Suggestions about Ventilation, Drainage, Care of Contagious Diseases, Disinfection, Food, and Water. With Appendices on Disinfectants and Plumbers' Materials. By ROGER S. TRACY, M. D., Sanitary Inspector of the New York City Health Department. New York: D. Appleton & Co. Pp. 110. Price, 50 cents.

THERE are now but few persons who have the hardihood to say that hygienic knowledge, or information concerning the preservation of health, is without value. But if it have any value whatever for its purpose, then is it of very great importance, for the maintenance of health and life is the supremest earthly interest. It may of course be said that our fathers got along very well without all this bother about ventilation, drainage, and other hygienic matters, but this is only an apology for ignorance, or a plea for indolence. Through the whole history of the world, and everywhere, long life and vigorous health have been dependent upon the necessary conditions, and, where these have been wanting, feebleness, invalidism, severe sickness, premature death, and the destruction of countless thousands by pestilence, have been the results. In the ignorant ages—the theological ages, when the phenomena of sickness and death were accounted for by the providence of God, against which it was in vain to strive—little was known of the real causes of disease, and it was therefore a subject that attracted but slight attention either privately or publicly. But in this more scientific age, devoted so assiduously to the extension and diffusion of knowledge, men are beginning to feel the importance of a better understanding of those physical conditions and physiological laws upon which health is dependent, and there is, of course, a good deal said about their urgency, and the need of reducing them to practical application. Ignorant and stupid people, and often excellent and pious people, are no doubt much bored by all this modern hygienic agitation, but in the happy order of the world this class of persons are certain to be gradually got out of the way, and they are to be replaced by others who will regard these subjects as not only of the first importance, but full of

the liveliest interest. A good sanitary education involves a very considerable understanding of the method of Nature.

We heartily welcome, therefore, the increasing hygienic literature of the age, and are glad to see that the best minds are devoting themselves to it, and giving the public the results in various forms of their serious and careful studies. The little volume now before us is a timely and most valuable contribution to the subject in its practical, every-day aspects for the use of householders. First of all, it is a careful and trustworthy book by a thoroughly prepared man, who has had large experience of hygienic subjects as Sanitary Inspector of the New York City Health Department. It has been Dr. Tracy's business to apply sanitary science to the art of living under our present domestic constructions and arrangements. He has had to meet actual difficulties that arise from the influence of bad air, bad sewerage, bad drainage, bad house-construction, bad precautions respecting infectious diseases, bad food, bad water, and bad plumbing. It seemed to him that there was needed a little book simply of facts and results, free from theory, discussion, or speculation, and written in the plainest style, that would serve for every-day guidance in relation to all these sanitary subjects. It is full of brief rules and directions, and useful information regarding sanitary contrivances, how they are to be obtained and what they cost, and from this point of view it may be regarded as a practical summing up of the most urgent requirements, the best facilities, and the clearest directions, that will be of service every day and to everybody. We have read the book with care, and can recommend it, without hesitation or qualification, as one that should be kept for constant reference in every house.

INTERNATIONAL SCIENTIFIC SERIES.

THE CONCEPTS AND THEORIES OF MODERN PHYSICS. Second edition, revised; with an Introductory Essay. By J. B. STALLO. New York: D. Appleton & Co. Pp. 358. Price, $1.75.

THE first edition, and a pretty large one, of this profound work was exhausted some time ago, which speaks well for the interest of American readers in the thorough discussion of the fundamental ideas that are at the basis of science and philosophy. The continued demand for the work making necessary a second edition, the author has subjected the text to a close revision, and prefixed to it a masterly introduction of forty-four pages. He here avails himself of the criticisms passed upon the work, both in this country and abroad (where several editions of it have also appeared), to restate the purpose of the volume, which has been a good deal misunderstood, and to reply to such objections as seemed to require attention. The effect of this lucid and brilliant discussion will be to greatly facilitate the general apprehension, and to enhance the interest of the work to those who take it up for the first time.

In our review of Judge Stallo's book upon its first appearance, we pointed out that it is a philosophical study of the relations of metaphysics to physics, designed to show that many of the leading physicists of the age are by no means as far emancipated from old metaphysical influences as it is customary to believe. He attacks some of the fundamental ideas of modern physics as being strictly metaphysical assumptions, and shows historically how they have survived, and performed their old duties in new relations. But the book was construed as an onslaught upon the foundations of modern physics in the interests of a bad metaphysics, and the author was called upon to offer his substitutes for the fundamental doctrines he aimed to sweep away. We quote some passages from the new introduction, which leave no room for further misunderstanding:

> The misapprehension I speak of is very surprising, in view of the explicit declaration, contained in the very first sentence of my preface, that the book is "designed as a contribution not to physics, nor certainly to metaphysics, but to the theory of cognition." Notwithstanding this declaration, most of my critics assume it to be my purpose to expose the short-comings and defects of particular theories as devices for the colligation of facts, or as instruments of research, and suppose that my endeavor is simply, as one of my critics expresses it, "to pick flaws in these theories," or, in the language of another critic, "to classify and develop contradictions" between them, to "set facts by the ears," and "bump friendly heads together"—in short, in the spirit of a sort of scientific pyrrhonism, to discredit the familiar methods of physical science, if not to invalidate its results. And they complain that I fail to apprehend what one of them is pleased to term the "laboratory function" of a physical

theory or hypothesis, and to appreciate the distinction between a "working hypothesis" and a theory advanced with the claim of its final validity or truth.

Now, the fact is, that for the purposes of the inquiry to which my book is devoted, I am not *directly* concerned with the "laboratory function" of "working hypotheses" or physical theories at all. My object is to consider current physical theories and the assumptions which underlie them in the light of the modern theory of cognition—a theory which has taken its rise in very recent times, and is founded upon the investigation, by scientific methods analogous to those employed in the physical sciences, of the laws governing the evolution of thought and speech. Among the important truths developed by the sciences of comparative linguistics and psychology are such as these: that the thoughts of men at any particular period are limited and controlled by the forms of their expression, viz., by language (using this term in its most comprehensive sense); that the language spoken and "thought in" by a given generation is to a certain extent a record of the intellectual activity of preceding generations, and thus embodies and serves to perpetuate its errors as well as its truths; that this is the fact hinted at, if not accurately expressed, in the old observation according to which every distinct form or system of speech involves a distinct metaphysical theory; that the metaphysical systems in vogue at any particular epoch, despite their apparent differences and antagonisms, on proper analysis are found to be characterized by certain common features in which the latent metaphysics of the language in which such systems have originated, or are presented, are brought to view; that philosophers as well as ordinary men are subject to the thralldom of the intellectual prepossessions embodied in their speech as well as in the other inherited forms of their mental and physical organizations, and are unable to emancipate themselves from this thralldom otherwise than by slow and gradual advances, in conformity to the law of continuity which governs all processes of evolution whatever. It being my belief that all this applies to the votaries of science as well as to the devotees of metaphysics or ontology, I sought to enforce this belief by an examination of the general concepts and theories of modern physics. According to the opinion of contemporary men of science, these concepts and theories are simply generalizations of the data of experience, and are thus not only independent of the old *a priori* notions of metaphysics, but destructive of them. But, although the founders of modern physical science at the outset of their labors were animated by a spirit of declared hostility to the teachings of mediæval scholasticism—a fact which is nowhere more conspicuous than in the writings of Descartes—nevertheless, when they entered upon the theoretical discussion of the results of their experiments and observations, they unconsciously proceeded upon the old assumptions of the very ontology which they openly repudiated. That ontology—founded upon the inveterate habit of searching for "essences" by the interpretation of words and the analysis of the concepts underlying them, before the relations of words to thoughts and of thoughts to things were properly understood—was characterized by three great errors: its hypostasis of concepts (notwithstanding the protest of the nominalists against the reification of universals); its disregard of the two-fold relativity of all physical phenomena; and its confusion of the order of intellectual apprehension with the order of Nature. These errors gave rise to a number of cardinal doctrines respecting the "substance of things," among which were the assertion of its existence as a distinct thing or real entity, apart from its properties; the further assertion of its absolute permanence and immutability; and, finally, the assertion of the absolute solidity and inertia of its parts and their incapacity to act upon each other otherwise than by contact. And all these doctrines lie at the base, not only of Cartesian physics and metaphysics, but of the scientific creed of the great majority of the physicists of the present day. The eminent physicist and physiologist who declares that "before the differential equations of the world-formula could be formed" (i.e., before the ultimate, true, and exhaustive theory of the universe could be constructed), "all processes of Nature must be reduced to the motions of a substratum substantially homogeneous, and therefore totally destitute of quality, of that which appears to us as heterogeneous matter—in other words, all quality must be explained by the arrangement and motion of such a substratum," and the equally distinguished physicist and mathematician who enters upon the attempt at a solution of the problem thus stated by endeavoring to deduce the phenomenal diversities and changes of the universe from imaginary vortical motions of the undistinguishable parts of an assumed universal, homogeneous, continuous, and incompressible fluid, are both as truly instinct with the spirit of the old *scientia entis quatenus entis* as the most ardent disciple of the Stagirite in the times of Erigena or Aquinas. The physicist who insists upon impact theories of gravitation, cohesion, or chemical affinity, has the same intellectual blood in his veins which coursed in those of the old disputants about "first matter" or "substantial forms." When the Professor of Physics in the University of Edinburgh teaches that matter is absolutely passive, *dead*, that all physical action is action by contact, that nothing is real which is not indestructible, etc., he stands as unmistakably upon scholastic ontological ground as did Descartes or any of his ecclesiastical contemporaries. The proposition of the modern kinematist, that the true explanation of the phenomena of heat, light, electricity, magnetism, etc., consists in their reduction to the elements of matter and motion, differs in little else than its phraseology from the metaphysical theorem that all the "secondary qualities" of the universal substance are mere specifications or derivatives of its "primary qualities."

ABORIGINAL AMERICAN AUTHORS AND THEIR PRODUCTIONS; ESPECIALLY THOSE IN THE NATIVE LANGUAGES. By DANIEL G. BRINTON. Philadelphia: 115 South Seventh Street. Pp. 63. Price, $1.

THE present memoir is an enlargement of a paper which the author presented to the International Conference of Americanists at

its last meeting in Copenhagen, in August, 1883. In it Dr. Brinton shows that the native Americans had a literary faculty, which is indicated by a vivid imagination, a love of narration, and an ample, appropriate, and logically developed vocabulary. They have left behind them a creditable literature of considerable extent which would have been larger, but much of it was wantonly destroyed by their self-styled civilized conquerors. They wrote in their own language, in Spanish, and in Latin, narrative, didactic, and oratorical works, poems, and dramas, the general character of which is briefly sketched and a partial list given. The Northern Indians are less fully represented in this literature than the Mexican and South American.

CASSELL'S FAMILY MAGAZINE, American edition. January and February, 1884. New York: Cassell & Co., Limited. Pp. 64 each. Price, 15 cents a number; $1.50 per year.

"CASSELL'S MAGAZINE" is conducted with reference to the tastes of the family, and is designed to furnish that which will profit as well as amuse. Well-selected fiction is provided, in serial stories as well as in those that are completed in one number; and in addition to this are given, regularly, papers on "Household Management," "Domestic Cookery," "Gardening," "Education and Recreation," the "Family Doctor's Papers"; a department for the discussion of social questions of the day, papers on remunerative employment for women, records of useful inventions and discoveries, and numerous illustrations.

NATURAL PHILOSOPHY. By ISAAC SHARPLESS, Sc. D., and G. M. PHILIPS, A. M. Philadelphia: J. B. Lippincott & Co. 1884. Pp. 350.

So many text-books on natural philosophy have appeared within the past few years that the teacher of to-day is embarrassed by the surplus of riches. In most of these an effort may be observed to introduce the only true method, that of personal experimentation. Many difficulties remain to be overcome, and the task is not an easy one. Although the authors state in their introduction that this treatise differs from others in the large number of practical experiments and exercises which it contains, we are somewhat disappointed at the small number of novel and simple experiments adapted to the average school-room, while more difficult and dangerous experiments are given in detail, such as the preparation of cyanide of silver from a silver coin for electro-plating. In other cases there is a lack of fullness, as for example, under electrolysis of water no mention is made of the kind or size of battery required; under electrophorus the composition of the rosin-cake is not given, and the pupil is led to infer that it is pure rosin. Neither the Holtz nor Windhurst electrical machines is pictured and described, but the old cylindrical machine takes their place. The Morse registering apparatus is illustrated instead of the sounder actually in use, and the duplex, quadruplex, and ocean-cable systems are referred to in a manner neither satisfying nor instructive. Notwithstanding these obvious defects, there is much to recommend the book as quite equal to the average text-books on this subject, and in some respects it is an improvement on them. The illustrations are excellent, the type clear, and the paper good.

TRANSACTIONS OF THE AMERICAN DERMATOLOGICAL ASSOCIATION at the Seventh Annual Meeting, August, 1883. By Dr. ARTHUR VAN HARLINGEN. Baltimore: Thomas & Evans. Pp. 49.

THE pamphlet contains the official report of the proceedings of the Association, with abstracts of the papers read, a list of publications and writings of members of the Association during the year ending in July, 1883, and a statistical report of cases treated.

THE WINTER RESORTS OF FLORIDA, SOUTH GEORGIA, LOUISIANA, TEXAS, CALIFORNIA, MEXICO, AND CUBA. By JOHN TEMPLE GRAVES. Published by the Passenger Deparment of the Savannah, Florida, and Western Railway Company. Pp. 103, with Maps and Illustrations.

AN attractive and popular guide-book to a whole region of health resorts and winter residences that are every year attracting more attention. It furnishes brief descriptions of the points of interest to the tourist, invalid, immigrant, or sportsman, and of the way to reach them.

GOD AND THE STATE. By MICHAEL BAKOUNINE, Founder of Nihilism and Apostle of Anarchy. Translated by BENJAMIN R. TUCKER. Boston: Benjamin R. Tucker. Pp. 52. 15 cts.

THE name of the author of this pamphlet ought to give a sufficient indication of its character. His apostleship of anarchy appears to have been as active in a religious as in a social and political aspect. We are informed that the work "contains an attack upon the theistic idea from a new stand-point, which, if successful, will result in tremendous consequences." It is certainly of interest to the student of mental phenomena, and of the order of social movements of which the author is a most conspicuous representative. A preface is furnished by Carlo Cafiero and Elisée Reclus.

POPULAR ESSAYS ON THE MOVEMENTS OF THE ATMOSPHERE. By Professor WILLIAM FERREL. Washington: Government Printing-Office. Pp. 59.

THE papers that make up this volume were originally published in the "Nashville Journal of Medicine and Surgery," "The American Journal of Science," and "Nature." They relate to the winds and currents of the ocean; the motions of fluids and solids relative to the earth's surface; the cause of low barometer in the polar regions and in the central part of cyclones; the relation between the barometric gradient and the velocity of the wind; and researches on cyclones, tornadoes, and waterspouts.

ELEMENTARY BOTANY, with Student's Guide to the Examination and Description of Plants. By GEORGE MACLOSKIE, D. Sc., LL. D., Professor of Natural History in the J. C. Green School of Science, Princeton, N. J., and Medalist of Queen's and London Universities. New York: Henry Holt & Co. 1883.

MACLOSKIE'S "Botany" is a marked departure from our cherished models of botanical text-books, and we confess that it has taken considerable time for us to get accustomed to its novelty. It is a wholly modern work, and conforms to the revolution of method that followed the translation of "Sachs's Botany," from the German. The body of the book, which is devoted to the general principles of the science, is unusually free from the technicalities of text-books. The treatment is very fresh and interesting, and in his aim to supply a readable sketch of botany the author has well succeeded.

As a "guide to work in the field and laboratory," if supplemented by the further guidance of the master, the work will no doubt prove a success; but as a manual for private study it strikes us as unattractive and unsatisfactory. But such a use of it was probably not in the author's mind in its preparation.

Many people will object to Macloskie's innovations in descriptive botany. If anything in science is firmly settled it is thought that botanical technology might make the claim. But our author has not scrupled to alter and amend its time-honored usages; yet, if improvement be a sufficient warrant for change, we suspect that he can justify himself. He has certainly gained in brevity, if not in greater precision of statement, by which beginners in the study will be gainers. Old botanists, however, will be slow to adopt the new terms. We cordially commend the volume to that large class of readers who wish to know something of the fundamental principles and philosophical bearings of this important science.

THE SUN CHANGES ITS POSITION IN SPACE, THEREFORE IT CAN NOT BE REGARDED AS BEING "IN A CONDITION OF REST." By AUGUST TISCHNER. Leipsic: Gustav Fock. Pp. 37.

THE obvious truth expressed in the title is used as a basis of attack upon the adequacy of the received theories of astronomy. "The smallest movement of the sun," says the author, "overthrows the entire fabric of Copernicus." If the sun is moving, the orbits traversed by the planets can not be closed; and the astronomical dictum that, with reference to the planets, we may regard the sun as being in a state of rest, involves absurdity, for it assumes a motion which is at rest.

A DICTIONARY OF MUSIC AND MUSICIANS. Edited by GEORGE GROVE, D. C. L. Parts XVII and XVIII. London and New York: Macmillan & Co. Pp. 240. $2.

THE present double part of the "Dictionary" contains the titles from "Sketches" to "Sumer is icumen in," with the title-page

and a list of contributions to Volume III. The article in the midst of which the part opens, on "Sketches," is one of great interest, and is liberally illustrated with musical citations. "The Sonata" is fully considered. Forty-eight pages are given to the subject of "Song," which is treated historically and systematically with reference to the characteristic features of the songs of different nationalities. The work appears destined to be one that no musician will be willing to be without.

EVOLUTION: A SUMMARY OF EVIDENCE. By ROBERT C. ADAMS. New York: G. P. Putnam's Sons. Pp. 44.

THIS paper is the substance of a lecture delivered in Montreal, in which the evidence in favor of the doctrine of evolution is reviewed and stated in brief in a very clear and forcible manner. Concerning the orders of life, the author shows that animals and plants appear as they would have done if one race sprang from another; that each being does spring from (embryonic) forms common to the races below it; and that life has appeared on the earth in the order that it would have done if each higher race had been developed from a lower one. Brief consideration is also given to the evolution of mind and of the universe as postulated by the nebular hypothesis; and, finally, the author, admitting that evolution does not solve all the mystery of life, asserts that it does not either question the existence of God, but "only concerns itself as to the manner in which the Supreme Power works, and claims that it acts through natural law, and not through miracle.

LESSONS IN QUALITATIVE CHEMICAL ANALYSIS. By Dr. F. BEILSTEIN. Translated, with Copious Additions, by Charles O. Curtman, M. D. St. Louis Stationery and Book Co. 1883. Pp. 164, and Thirteen Woodcuts. Price, $1.50.

DR. BEILSTEIN'S little work is the textbook in several German and Russian universities, and more than one English translation has already appeared in this country. The present translation differs essentially from the previous ones in the amount of new matter added. The short introduction on chemical manipulations will prove valuable to the student who is working alone or in laboratories imperfectly supplied with instructors, and in any case saves a great deal of oral teaching and demonstration. Next follow the special examples of the original with several additional ones, but rearranged so as to place the reactions for bases and acids under separate headings, and eliminating those which require too long a time in preparation. A new chapter is then introduced to serve as a guide in the various practical examinations during the course. An excellent table of spectra accompanies the book, with a chapter on the use of the spectroscope. Directions are also given for the detection of a few organic substances such as alcohol, chloroform, glucose, phenol, and the alkaloids. The book closes with a chapter of thirty-eight pages on volumetric analysis, in which very full directions are given for preparing test solutions, with description of apparatus employed. The course embraced in Dr. Curtman's book is sufficient for physicians and others who do not intend to become chemists, while it is a useful introduction to a more thorough course for the latter.

A MANUAL OF CHEMISTRY, PHYSICAL AND INORGANIC. By HENRY WATTS, B. A., F. R. S. Philadelphia: P. Blakiston, Son & Co. 1884. Pp. 595.

THE name of Watts is already familiar to the chemists of all countries, not only as the author of the only complete dictionary of chemistry in the English language, but also as the editor of the leading English journals of that science, "The Chemical News" and the "Journal of the London Chemical Society." In 1868 Mr. Watts revised Fowne's well-known "Manual of Chemistry," and from time to time new editions of that work have appeared under his editorial care. The book continued to increase in size until it became necessary to divide it into two volumes, the one containing the inorganic and physical portion, the other being devoted to organic chemistry. The work before us is but a new edition of the first volume of Fownes's, having the same ancient woodcuts, and in most cases the same matter accompanies them. We notice, however, new cuts of a Holtz machine and a Ruhmkorff's coil, but none of any modern dynamo, although the obsolete cylinder machine is still paraded before the reader. In

matters more intimately associated with the chemical laboratory there is less to criticise. Sprengel's air-pump is illustrated and described (Bunsen's modification is not); the modern methods of determining vapor densities, devised by Hofmann and Victor Meyer, are illustrated and explained. The theoretical portions have been mostly rewritten, and many improvements are noticed. The order of studying the non-metals has been changed so that the halogens precede oxygen and other dyads. The metals are grouped in their natural order, so that silver no longer finds itself in the same box with sodium, as it did in the artificial grouping according to quantivalence adopted in previous editions.

ABSTRACT OF REPORT ON THE GEOLOGY OF THE EUREKA DISTRICT, NEVADA. By ARNOLD HAGUE. Washington: Government Printing-Office. Pp. 48, with Map and Sections.

THE Eureka District embraces a region about twenty miles square, situated on the Nevada Plateau, in Central Nevada, midway between the basins of Lake Lahontan and Lake Bonneville. It is doubtful, in the opinion of Mr. Hague, if there is any region of equally restricted area in the Great Basin that surpasses it in its grand exposures of palæozoic formations, especially of the lower and middle portions of the series. It also possesses a great economic interest as the seat of an active mining industry, and has been, moreover, the center of intense volcanic action. It is therefore selected for a more careful survey and study than had heretofore been given to any region of sedimentary rocks in Nevada. The results of this survey and study are recorded in the present memoir.

UNITED STATES GEOLOGICAL SURVEY. Second Annual Report, 1880–'81. Pp. 588, with 61 Plates; Third Annual Report, 1881–'82. Pp. 564, with 32 Plates. By J. W. POWELL, Director. Washington: Government Printing-Office.

MANY of the special papers included in the second volume of the report have already been noticed in the "Monthly," as monographs. The whole list includes Captain Dutton's "Tertiary History of the Grand Cañon District," Mr. Gilbert's "History of Lake Bonneville," Mr. Hague's "Geology of the Eureka District," Mr. S. F. Emmons's "Geology of Leadville," Mr. G. F. Becker's "Geology of the Comstock Lode," Professor Pumpelly's "Statistics of Coal and Iron," Dr. Irving's Copper-bearing Rocks of Lake Superior," Mr. Clarence King's "Precious Metal Statistics," Mr. Eliot Lord's "History of the Comstock Lode," and Mr. G. K. Gilbert's "New Method of Hypsometry." The other volume (third report) contains papers on "Birds with Teeth," by Professor O. C. Marsh; "The Copper-bearing Rocks of Lake Superior," by Roland D. Irving; the "Geological History of Lake Lahontan," by Israel C. Russell; "The Geology of the Eureka District, Nevada," by Arnold Hague; a preliminary paper "On the Terminal Moraine of the Second Glacial Epoch," by Thomas C. Chamberlin; and "A Review of the Non-Marine Fossil Mollusca of North America," by Dr. C. A. White.

THE NATURAL GENESIS. By GERALD MASSEY. New York: Scribner & Welford. 2 vols. Pp. 552 and 535.

MR. MASSEY has given his critics a hard task to perform. He states that Mr. Alfred Russel Wallace, having read the previous volumes of his series, expressed the fear that there might not be a score of people in England who were prepared by their previous education to understand the book; and he intimates that few of its reviewers could be included among that number. Herr Pietschmann, a German Egyptologist, was startled by the "unheard-of suggestions" the book contained, and thought it was "inspired by an unrestrained lust for discovery." "The Natural Genesis" is the second part of "A Book of the Beginnings," of which two volumes had previously been published, the whole containing "an attempt to recover and reconstitute the lost origins of the myths and mysteries, types and symbols, religion and language, with Egypt for the mouth-piece and Africa as the birthplace." It is written "by an evolutionist for evolutionists," is intended to trace the natural origins and teach the doctrine of development, and is based upon the new matter supplied by the ancient monuments. The predominant argument of the book is, that Africa and not Asia was the birthplace of articulate man, and therefore the primordial home of all things human;

and that the human race and human development started from the interior of the dark continent, and went out down the Nile and through Egypt, confessedly the oldest civilized nation, to all the quarters of the earth. As a corollary to this, all customs, all myths, all civilization, all speech, and all religion, had their origin in Egypt, and are traceable directly back there. Another corollary is that all the sociological science and comparative philology that have been built up on the theory of a primitive Aryan race and civilization and language are idle speculations, except as these Aryan institutions are admitted to be children of the Egyptians. The Christian religion also suffers at Mr. Massey's hands; for this work, to use his own language, "culminates in tracing the transformation of astronomical mythology into the system of equinoctial Christology called Christianity, and demonstrating the non-historic nature of the canonical gospels by means of the original myths in which the Messianic mystery, the Virgin motherhood, the incarnation and birth, the miraculous life and character, the crucifixion and resurrection of the Saviour Son, who was the Word of all ages, were altogether allegorical." Having devoted a dozen years exclusively to his work, Mr. Massey has been able to bring to his aid a vast amount of learning, and has used it with considerable ingenuity. His text abounds with interesting facts and citations not to be found elsewhere in a whole library, and with skillful applications. If his conclusions do not carry conviction, it is not for lack of bravery and address on the part of their champion.

On the Contents of a Bone-Cave in the Island of Anguilla (West Indies). By Edward D. Cope. Washington: Smithsonian Institution. Pp. 30, with Five Plates.

Attention was first called to the interesting bone-deposit described in this memoir in 1868, when a load of the cave-earth was brought to Philadelphia as a fertilizing material, and the bones were examined by Professor Cope. Together with the bones was found a chisel of human manufacture, made from a shell. The quantity of animal remains in the deposit and their dimensions point to the former existence of a more extensive and larger fauna than the island as it now stands could have supported. This fact is regarded as confirmatory of the hypothesis that the Antilles were once connected by ranges which have been submerged since Pliocene times. In the light of these facts, Professor Cope claims that the study is of importance, because it is the first investigation of the life of the cave age in the West Indies; because it gives the first reliable indication of the period of the submergence by which the islands were separated; because it furnishes the first evidence as to the antiquity of man there; and because it describes some peculiar forms of life not previously known.

Cruise of the Revenue Steamer Corwin in Alaska and the Northwest Arctic Ocean, in 1881. Notes and Memoranda. Washington: Government Printing-Office. Pp. 120.

The notes include a very interesting paper by Dr. Irving C. Rosse, on the medical features of the expedition, with anthropological memoranda respecting the Esquimaux, and the effects of the Arctic climate on the members of the expedition and the natives; botanical observations, by Mr. John Muir; description of the birds of Behring Sea and the Arctic Ocean, by E. W. Nelson; and a list of fishes, by Tarleton H. Bean. The text is illustrated with heliotype and colored lithographic plates.

Report on the Oyster-Beds of the James River, Virginia, and of Tangier and Pocomoke Sounds, Maryland and Virginia. 1881. By Francis Winslow, U. S. N. Washington: Government Printing-Office. Pp. 87, with Plates.

This monograph is one of the series of "Methods and Results" of the United States Coast and Geodetic Survey. In it, Captain Winslow presents the results of an investigation which he was ordered in 1878 to make with the schooner Palinurus, and which should include the determination of the positions and areas of the oyster-beds and the depth of water over them, at both high and low water; the determination of the character of the beds, whether natural or artificial, and how the oysters were distributed; the determination of the temperatures of the surface and bottom water, and the velocity of currents; the preservation of specimens of oysters; the determination

of the characters of bottoms and of the existence of any sediment or deposit; of the sources of sediment and the means of turning it away; the examination of the effects of ice on the beds; and the determination of the density of the water, with special reference to the displacement of salt water by fresh water from adjacent streams and rivers. The plan of the work was to make the investigation exhaustive over a limited area, and extend it afterward as circumstances should permit. The results are given in the present memoir.

EXPLOSIVE MATERIALS. By M. P. E. BERTHELOT. Translated from the French by Marcus Benjamin. New York: D. Van Nostrand. (Science Series.) 1883. Pp. 180. Price, 50 cents.

IN these lectures M. Berthelot has summed up the results of his researches upon explosives, and indicated the theory of their action which they seem to him to warrant. He is mainly concerned in considering how an explosive is set in operation by means of shock, and reaches the conclusion that in all cases, whether the explosive influence be propagated from particle to particle of an explosive, or from one explosive body to another, not in contact with it, the action consists in the transformation of the energy of the shock into heat. Before an explosion can occur, some portion of the substance must be raised to the temperature necessary for the chemical reaction between its constituents. That this temperature should be reached, it is necessary that the impact be sudden, as otherwise the transformation into heat will take place so slowly that this heat will be distributed through too great a mass of material to raise its temperature to the requisite point. The explosion of one particle of the substance produces a sudden pressure, the energy of which, transformed into heat, causes the next particle to explode, and so on, the disturbance being thus propagated through the entire mass of the explosive. M. Berthelot rejects the synchronous theory of explosions by influence—where a body is exploded by another at a distance—of Abel, holding that the theory of transformation of mechanical energy into heat, and the retransformation of this into mechanical energy, is competent to explain all the phenomena. In discussing the conditions of maximum effect in explosion, he points out the reason for the extremely low velocity of propagation of the explosive wave in gases, obtained by Bunsen, and shows that this in reality moves with great rapidity.

Mr. Benjamin's translation appears to be accurate, and, despite occasional roughness, is fairly well done. The volume contains also a short historical sketch of gunpowder, translated from the German of Karl Braun, and a bibliography of works on explosives.

THE ORES OF LEADVILLE AND THEIR MODES OF OCCURRENCE, AS ILLUSTRATED IN THE MORNING AND EVENING STAR MINES. With a Chapter on the Methods of their Extraction as practiced at those Mines. By LOUIS D. RICKETTS, B. S., Princeton, N. J. Pp. 68, with Six Plates.

THE author, in order to comply with the requirements of the W. S. Ward Fellowship in Economic Geology, in connection with Princeton College, devoted four months at Leadville to the study of the ores and their modes of occurrence, and to the extraction of the ores in the mines named in the title we have cited. The result of this study is given in the present paper, of which the first part considers the scientific and the second part the practical side.

J. A. BERLY'S BRITISH, AMERICAN, AND CONTINENTAL ELECTRICAL DIRECTORY AND ADVERTISER. London: William Dawson & Sons; New York: George Cumming, 219 East Eighteenth Street. Pp. 664. Price, $2.50.

THIS volume, which embodies a record of all the industries directly or indirectly connected with electricity and magnetism, and the names and addresses of manufacturers in England, the United States, Canada, and the European Continent, is a valuable book of reference for all persons interested in electrical art. The increased size and importance of this, the second edition, over the volume published a year previously, which was chiefly limited to England, is one of many signs of the rapidly expanding development of the applications of electricity. Another similar sign is afforded by the variety of trades—some of them appearing at first sight only very remotely related to electricity—that have been included within its scope. The relation is nevertheless real, for all these trades have been brought in to

comply with some demand. A brief, comprehensive record of the progress in the applications of electricity and of events illustrating it, during 1882, adds value to the work. Classified indexes are provided, and reference is further facilitated by differences in the coloring of the leaf-edges of the several departments.

RECHERCHES SUR LA STRUCTURE DE QUELQUES DIATOMÉES CONTENUES DANS LE "CEMENTSTEIN" DU JUTLAND (Researches on the Structure of some Diatoms contained in the "Cementstein" of Jutland). By MM. W. PRINZ and E. VAN ERMENGEN. Brussels: A. Manceaux. Pp. 74, with Four Plates.

A RECORD of a minute and careful examination of the curious organic structures designated, of particular interest to microscopists and students of the *Diatomaceæ*. The authors claim, moreover, a kind of educational interest and utility for studies of the class to which this one belongs, because acquaintance with the exact forms of the varied and delicate designs that adorn the siliceous envelopes of the microscopic algæ facilitates the interpretation of similar images that appear in other microscopic investigations, and furnishes a safeguard against the causes of error and illusions to which microscopists are exposed from the presentation of figures under their instruments which do not conform to the reality.

GEOLOGICAL SURVEY OF ALABAMA. Report for 1881 and 1882. By EUGENE ALLEN SMITH, Ph. D., State Geologist. Montgomery, Alabama: W. D. Brown & Co. Pp. 614, with Maps.

THE present volume of the reports is devoted chiefly to an account of the agricultural features of the State. The author was commissioned to prepare the cotton report of Alabama in connection with the tenth census, and by joining the two works has been able to make both more complete than he could have made either separately. Special attention is given to the descriptions of the soils, as to the State and by counties, of timber-trees and other plants, and to cotton production. Excellent graphic, colored maps are inserted, showing the soils, the rainfall and temperature by the seasons and by the year, and the percentages of land in different parts of the State cultivated in cotton.

FIRST ANNUAL REPORT ON THE INJURIOUS AND OTHER INSECTS OF THE STATE OF NEW YORK. By J. A. LINTNER, State Entomologist. Albany: Weed, Parsons & Co. Pp. 383.

DR. LINTNER has given a large amount of information on the subject of his report. Beginning with an exposition of the importance of entomological study, he considers the extent of insect depredations and the losses from them, particularly in the United States, the immense number of insects, and the necessity, for the sake of contending with them, of acquiring knowledge of their habits. He then reviews the progress that has been made in economic entomology, estimates the value of the various insecticides that have been introduced and of other remedies for and preventives of insect depredations, after which he furnishes descriptions and life-histories of the more injurious insects. Among the preventives of insect depredations suggested by Dr. Lintner is one which we believe is new: it depends upon the theory that insects are attracted to the plants they infest by the odor, and consists in the use of some substance by which that odor may be overcome or neutralized.

HINTS ON THE DRAINAGE AND SEWERAGE OF DWELLINGS. By WILLIAM PAUL GERHARD, Civil Engineer. New York: William T. Comstock, 6 Astor Place. 1884. Pp. 302. Price, $2.50.

THIS little work has grown out of a series of articles contributed by the author, under the signature "Hippocrates," to the periodical "Building." Its object is to give an account of the usual condition in which plumbing-work done years ago, and some quite recently done, may be found, and to give suggestions on the proper manner of doing the work. A valuable report on "Filth Diseases and their Prevention," by medical officer John Simon, of Great Britain, and other works on dwelling-house sanitation are referred to to fortify conclusions. The book is frequently illustrated with examples of bad work to be avoided and of good work to be patterned after.

THE TRICHINIASIS QUESTION.—D. Appleton & Co., of New York, will publish shortly a work on "The Relation of Animal Diseases to the Public Health, and their

Prevention," by Frank S. Billings, V. S., Boston. The trichiniasis question, now a subject of congressional investigation, is fully discussed by the author, whose researches on this subject have been thorough and long continued. He has also compiled many valuable statistics having a direct bearing on the question, and which are contained in no other volume in the English language. The book should be read by all who have an interest in the settlement of this most important question.

PUBLICATIONS RECEIVED.

The Correspondence University: Announcement for 1884, January. Ithaca, N. Y.: Lucien A. Wait. Pp. about 50.

Archæological Excursions in Wisconsin and Ohio. By F. W. Putnam. Pp. 16.

Massachusetts Agricultural College: Twenty-first Annual Report. Boston: Wright and Potter Printing Company. Pp. 78.

Pilot Chart of the North Atlantic for February, with Supplement of 3 pages showing position and detail of floating wrecks.

Inaugural Addresses of Stephen A. Walker, President of Board of Education, etc., of the City of New York. Pp. 22.

Beitrag zur Kenntniss der Kobalt,- Nickel,- und Eisen-Kiese. (Contribution to the Knowledge of Cobalt, Nickel, and Iron Stones.) By Leroy W. McCay, M. A. Freiberg (Saxony). Pp. 46.

Out-Door Relief, State of New York: Report of Standing Committee. Albany, N. Y. Pp. 15.

New York State Board of Charities: Report on Establishment of a State Asylum for Indigent Blind. Albany, N. Y. Pp. 9.

Value of the Nearctic as one of the Primary Zoölogical Regions: Reply to Criticisms. By Professor Angelo Heilprin. Philadelphia. Pp. 10.

Radiation: A Function of Gravity. By I. E. Craig. Camden, Ohio. Pp. 21.

Renal Circulation during Fever. By Walter Mendelson, M. D., of New York. Pp. 24.

Recent School-Law Decisions. By Lyndon A. Smith. Washington: U. S. Bureau of Education. Pp. 82.

Bulletin of the Buffalo Society of Natural Sciences. Vol. IV, No. 4. Julius Pohlman, M. D., Corresponding Secretary. Buffalo, N. Y. Pp. 188.

Medico-Legal Society of New York: Inaugural Address of President Clark Bell, Esq., etc. Pp. 24.

Connecticut Agricultural Experiment Station: Annual Report for 1883. New Haven, Conn. Pp. 120

Diccionario Tecnológico: Inglés-Español y Español-Inglés. (Technological Dictionary: English-Spanish and Spanish-English.) By Nestor Ponce de Leon. No. 5. New York: N. Ponce de Leon. Pp. 48. 50 cents.

"Reception-Day." No. 3. (Readings and Recitations.) Quarterly, No. 3. New York: E. L. Kellogg & Co. Pp. 152. 30 cents each; $1 a year.

Massachusetts Institute of Technology: President's Report, 1883. Boston: J. S. Cushing & Co. Pp. 31.

Massachusetts Institute of Technology: Annual Catalogue, etc., 1883–'84. Boston: George H. Ellis. Pp. 144.

The Book of Plant Descriptions and Record of Plant Analyses, etc. By George G. Groff, A. M., M. D. Lewisburg, Pa.: Science and Health Publishing Company. Pp. 100. 30 cents.

Absence of Design in Nature. By Professor H. D. Garrison. Chicago. Pp. 19.

Manual Training-School of Washington University, St. Louis: Annual Catalogue, 1883–'84. Pp. 42.

The Teaching of Drawing in Grammar-Schools. By Walter S. Perry. Boston: The Prang Educational Company. Pp. 26.

The World's Industrial Cotton Centennial Exposition at New Orleans, Louisiana, to be opened in December, 1884: Announcement. Pp. 18.

"The Cornell University Register," 1883–'84. Ithaca, N. Y. Pp. 134.

Administrative Organization. By LL. B. Washington, D. C.: William H. Morrison. Pp. 108.

Woman Suffrage. By John George Hertwig. Pp 16. Sunday Laws. By John George Hertwig. Washington, D. C. Pp. 12. 10 cents each.

Reports of School Committee and of Superintendent of Schools of the City of Gloucester, Massachusetts, for 1883. Pp. 75.

Energy in Nature By William Lant-Carpenter. London, Paris, and New York: Cassell & Co. 1883. Pp. 212. $1.25.

Merv: A Story of Adventures and Captivity. By Edmond O'Donovan. New York: Funk & Wagnalls. 1884. Pp. 313. $1.

Martin Luther: A Study of Reformation. By Edwin D. Mead. Boston: George H. Ellis. 1884. Pp. 194. $1.25.

The Land Laws. By Frederick Pollock. London: Macmillan & Co. 1883. Pp. 215. $1.

Bleaching, Dyeing, and Calico-Printing. Philadelphia: P. Blakiston, Son & Co. 1884. Pp. 303. $1.75.

Momu and the Diary of a Superstitious Man. By Ivan Turgenieff. Translated by Henry Gersoni. New York: Funk & Wagnalls. 1884. Pp. 131. 75 cents.

Prusias: A Romance of Ancient Rome. By Ernst Eckstein. Two vols. New York: William S. Gottsberger. 1884. Pp. 355 and 355.

Clavis Rerum. Norwich, Conn.: F. A. Robinson & Co. 1883. Pp. 142. $1.

Memorie and Reine. By Joaquin Miller. New York: Funk & Wagnalls. 1884. Pp. 237.

The Topographer: His Instruments and Methods. By Lewis M. Haupt, C. E. New York: J. M. Stoddart. 1885. Pp. 184. Illustrated.

"Patents and Inventions: A Quarterly Patent-Law Review." By Henry Connett and Arthur C. Fraser. Vol. I. New York: Burke, Fraser & Connett. 1884. Pp. 214.

First Annual Report of the Provincial Board of Health of Ontario. Toronto: C. Blackett Robinson. 1883. Pp. 187.

Journal of Proceedings and Addresses of the National Educational Association of the United States, Session of 1883. Boston: J. E. Farwell & Co. printers. 1884. Pp. 210.

Record of Family Faculties, consisting of Tabular Forms and Directions for entering Data, pp. 62. 90 cents; and Life-History Album. By Francis Galton, F. R. S. London: Macmillan & Co. 1884. Pp. 172. $1.25.

Bacteria. By Dr. Antoine Magnin and George M. Sternberg, M. D. New York: William Wood & Co. 1884. Pp. 454.

A System of Rhetoric. By C. W. Bardeen. New York: A. S. Barnes & Co. 1884. Pp. 673. $1.50.

Life and Times of the Right Hon. John Bright. By William Robertson. London and New York: Cassell & Co. Pp. 688. $2.50.

The Unity of Nature. By the Duke of Argyll. New York: G. P. Putnam's Sons. 1884. Pp. 571. $2.50.

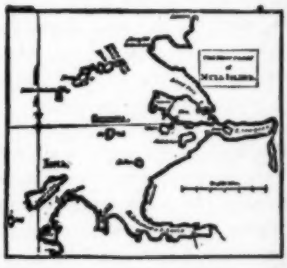
POPULAR MISCELLANY.

Durability of Building-Stones. — Dr. Alexis A. Julien has made examinations of buildings of various ages, and of tombstones in some of the older grave-yards around New York city, to assist in determining the durability of the various stones used in building. The coarse brown-stone, which is largely employed, appears to be one of the most perishable materials in use, so that many builders are returning to brick, although the finer varieties of brown-stone are better and compare favorably with other materials. Among the causes for the decay of this stone are mentioned, erection on the edge of lamination, the heat of the sun on exposed sides, and imperfect pointing, with poor mortar, which falls away and leaves the joints exposed to the weather. The presence of sea-salt in the atmosphere has exerted no appreciable effect, and lichens growing on the stone do not appear to have occasioned any decay or corrosion. The light-colored Nova Scotia sandstones have been too recently introduced to show marked defect, but evidences of exfoliation and of slight moldering in damp spots have begun to appear. Buildings constructed of the Amherst (Ohio) sandstone show little decay, only discoloration; and that is regarded as a favorable sign rather than otherwise, for it indicates durability, while a stone that cleans itself does so by disintegration of its surface, the grains dropping out and carrying away the dirt. The coarse fossiliferous limestone from Lockport has disintegrated rapidly within the last ten years, chiefly on account of careless arrangement in masonry. The oölitic stone from Ellettsville, Indiana, shows an almost immediate and irregular discoloration, said to be produced by the exudation of oil. The oölite from Caen, France, has shown decay in several instances where it was not protected by paint. The dolomitic marble of Westchester County has decayed considerably after sixty years of use, but much of this is owing to the stone having been improperly laid. Often marbles, of various kinds, in tombstones, are in fairly good condition. Horizontal slabs show a tendency to bend. The frequent obliteration of inscriptions, the general and often rapid granulation of the surface, and the occasional fissuring of slabs, show that the decay of marble—in the varieties hitherto long used in New York city—is steady, inevitable, and but a question of time; and, if unprotected, this material is likely to prove utterly unsuitable for out-of-door use, at least for decorative purposes or cemetery records, within the atmosphere of a city. A blue-stone, or graywacke, is yearly coming into more general use, and, though somewhat somber in tone and difficult to dress, seems likely to prove a material of remarkable durability. The bluish Quincy granite has been used in many buildings, and rarely shows as yet many signs of decay. A fine-grained granite from Concord, New Hampshire, also promises to be durable. The light-colored and fine-grained granite of Hallowell, Maine, in which the white feldspar predominates, has shown some exfoliation, but in the single building in which this is remarked the stones appear to have been set on edge, and, as their structure is laminated, that is an important matter. "The weathering of granite does not proceed by a merely superficial wear, which can be measured or limited by fractions of an inch, but by a deep insinuation along the lines of weakness, between grains, through cleavage-planes, and into latent fissures. Thus, long before the surface has become much corroded or removed, a deep disintegration has taken place by which large fragments are ready for separation by frost, from the edges and angles of a block. When directly exposed to the heat of the sun, an additional agency of destruction is involved, and the stone is suddenly found ready to exfoliate, layer after layer, concentrically." The following is an approximative estimate of the "life" of different kinds of stone, signifying by the term life, without regard to discoloration or other objectionable qualities, merely the period after which the incipient decay of the variety becomes sufficiently offensive to the eye to demand repair or renewal: coarse brown-stone, five to fifteen years; laminated fine brown-stone, twenty to fifty years; compact fine brown-stone, one hundred to two hundred years; blue-stone, untried, probably centuries; Nova Scotia stone, untried, perhaps fifty to two hundred years; Ohio sandstone (best sili-

ceous variety), perhaps from one to many centuries; coarse fossiliferous limestone, twenty to forty years; fine oölitic (French) limestone, thirty to forty years; fine oölitic (American) limestone, untried here; coarse dolomite marble, forty years; fine dolomite marble, sixty to eighty years; fine marble, fifty to two hundred years; granite, seventy-five to two hundred years; gneiss, fifty years to many centuries. Many of the best building-stones in the country have never yet been brought to the city.

Peroxide of Hydrogen.—Peroxide of hydrogen, though it was discovered in 1818, has only recently, by the aid of cheapened processes of preparation, come into general use. When pure, it is a colorless liquid, which in decomposing gives off four hundred and seventy-five times its volume of oxygen. Diluted solutions of it, kept in the dark at a temperature of not more than 80°, may be preserved for a very long time without decomposing. It is obtainable pure, in large quantities, and cheaply, in solutions of three per cent by weight or ten per cent by volume; and it has come into extensive use as a bleaching agent, for disinfection, household purposes, and the toilet. It is the really operative agent in air-bleaching on the grass, which has been in use from time immemorial, and is well adapted for bleaching substances of animal origin, in which chlorine agents often fail. In using it the substance to be bleached must first be carefully cleansed from dirt and oil. It may be applied as a bath in the shape of a weakly acid solution neutralized with a few drops of ammonia, or the substance may be dipped in it, and afterward slowly dried in the air. As the water evaporates, the concentration of the peroxide of hydrogen increases, and the bleaching goes on more energetically. Dumas and Pettenkofer have applied peroxide of hydrogen with much success and satisfaction to the cleaning of oil-paintings and engravings. This substance has recently been found to be one of the most valuable and effective disinfecting agents. In the household it has proved to be equal to the best of other known substances for purposes of washing and cleansing the person. It is adapted to the most tender skins. It has been pronounced preferable as a tooth-wash to all powders and to all other preparations which do not depend upon it. In bathing, with the addition of a drop or two of hartshorn, it quickly disintegrates and removes the dead skin without affecting the living tissue, except to make it more healthy and hardy. It is a salutary hair-wash, provided the hair has been prepared for it by previous washing with soap or spirit. Professors Alex. Classen and O. Bauer have found it a powerful agent in analytical chemistry.—*Die Natur.*

Fact and Fancy regarding Fingal's Cave.—At the Montreal meeting of the American Association in 1882, Mr. F. Cope Whitehouse offered a paper on "The Caves of Staffa, and their Connection with the Ancient Civilization of Iona." The Committee on Papers, having heard Mr. Whitehouse in exposition of his views, and examined his maps and drawings, and the testimonials which he was able to produce from men of authority in science, adjudged that there were sufficient merit and originality in his paper to justify giving it a hearing. The article was also regarded by us of enough interest to be given to the readers of "The Popular Science Monthly" in December, 1882; and a summary of it was published in "Notes and Queries," December 28, 1883. In it the author, regarding the situation of the Island of Staffa, which is shown in the map, the character of its



rocks, the form of Fingal's Cave, and the shape and direction of its exposure, concluded that it was extremely unlikely that the cave could have been hollowed out by the natural action of the waves, and suggested the question whether it might not have been artificially excavated. The paper has not yet been adequately an-

swered. But the author was held up to ridicule, in a leading article in "Nature" of January 25, 1883, as the victim of "a thirst for scientific renown," who knew nothing of the subject concerning which he had given the result of his studies, but had succeeded in imposing himself upon a respectable scientific body, and upon a scientific journal. Mr. Whitehouse has taken his time to answer this attack, and has replied to it with vigor and to the point in a late number of the "Manhattan." Setting by the side of one another photographs of the Island of Staffa and Fingal's Cave, and the representations of them given in the current works on geology, he shows that a wonderful ignorance of what they are like exists in the scientific mind, and is transmitted to students. German works exhibit a structure supposed to have been exposed for millions of years to waves capable of hollowing out two hundred and twenty-eight feet of basalt, and open at both ends, which Fingal's Cave is not, compared with which "a wall of bricks without mortar would be solidity itself." Hitchcock's "Geology" long gave a view that did not show any part of Staffa, but the adjoining Island of Boo-sha-la. Dr. A. Geikie, Director of the Geological Survey of Scotland, gave, in his "Primer" in 1881, "a tolerable engraving of part of the island"; but, in 1882, he offered to more advanced students, in his "Text-Book of Geology," "a problem in physics and drawing which has hitherto passed uncriticised," "the bad copy of a picture for which its author apologized in 1819," "which picture was no more Staffa than a view inside the railings at the head of Wall Street would be Trinity Church." If our young American has been too hasty in his theories, upon which we do not undertake to decide, it certainly behooves his critics, and especially those who are on the spot and wear official titles, to attempt some approach to accuracy in fact.

Why some Bodies feel colder than others.—It is a familiar fact that, when we touch with the fingers different substances of the same temperature, some will feel colder than others. The differences of the feeling are commonly ascribed to differences in the heat-conducting powers of the several bodies. A correspondent of "La Nature" suggests that, besides this, the specific heat of the bodies and the degree of polish of their surfaces should be taken into account. The effect of specific heat may be observed by pouring alcohol upon water and plunging the finger in so that a part of it shall be in the water and a part in the alcohol. The part in the water will feel much colder than that in the alcohol. So brandy may be taken, with safety, at a degree of cold at which water would infallibly irritate the skin. The effect of the degree of polish may be tried with a piece of marble or glass one side of which is smooth and another rough, with a file one side of which has been ground down, or with glazed and unglazed paper. In every case the smooth side or substance, at ordinary temperatures, will appear colder than the rough one. The fact may be accounted for by remembering that the smooth body presents vastly more points of contact with the fingers, and consequently more conductors for the heat than the rough one. In like manner a liquid always seems colder than the vessel containing it, because it is in closer contact with the skin.

Are there Birds with Teeth? — The "Transactions" of the Natural History Society of Leipsic contains a paper by Dr. Paul Fraisse, on teeth and tooth-papillæ in birds. It is generally admitted that there is a series of birds having real teeth in their bills. Among these are the fossil archæopteryx of Solenhofen, and the odontornithes, discovered by Professor Marsh in the North American cretaceous. The jaws of the latter birds were furnished with teeth, and also with cavities containing supplementary teeth, like those of crocodiles. The curious relations which these birds exhibit with reptiles, as a kind of transitional stage between the two orders, suggest the question whether any living birds have teeth. On this point, Dr. Fraisse remarks that Geoffroy Saint-Hilaire in 1821 discovered in two embryos of the parrot (*Palæornis torquatus*) papillæ which he regarded as tooth-sacs and as homologous with the rudimentary teeth of other animals. In one of the jaws there even seemed to be duplicate rudiments, as among the mammalia. Cuvier accepted this an-

nouncement with a kind of reserve, and remarked that the horny texture of the bill seemed to spread over these vascular papillæ much in the same manner as the enamel over mammals' teeth. Blanchard resumed the investigation in 1860, and found in certain birds, among them some parrots, formations imbedded in the jaws, which when microscopically examined presented considerable similarity in composition with dentine and in structure with teeth; and he concluded that those birds possessed a real dental system. Dr. Fraisse believes that papillæ are frequently present in the horny bill of the parrot, that they are rich in vessels and covered with a veneer of peculiarly adapted horn-cells which Blanchard took to be dentine, and which in microscopic sections have quite a resemblance to that formation; but that real teeth do not exist in birds. "Whether any first rudiments of teeth may have been the origin of the growth of horn-teeth is very doubtful; but in all probability the horn-teeth should be regarded as secondary formations." The teeth of the odontornithes, in which Professor Marsh has found dentine and enamel, are excepted from this conclusion.

Alcohol regarded as a Beneficial Agent.—Dr. William Sharpe, an English physician, has published a pamphlet in which he seeks to demonstrate that alcohol is a factor in human progress. Looking into the history of the subject, he finds that the vine and the product of the vine have been in olden times more intimately associated with man's intellectual growth and development than with his purely physical wants. The stimulus of alcohol, when judiciously controlled, "always leads to active and higher mental efforts on the part of individuals," thus producing a contrary effect to that of other stimulants, which tend rather "to bring about a contented state of dreamy inaction" and to repress effort. "To understand fully," he says, "the beneficial action of alcohol as regards mental development, we must first get a clear view of the value of those states of cerebral excitement which most people, though in varying degrees, experience something of, rising as they then do mentally above the level of what may be called their ordinary every-day thoughts. This is not difficult, if we bear in remembrance that it is during such periods of high mental activity, in which the mind, transcending the more circumscribed limits of reason, sweeps intuitively into the veiled and distant regions of universal truth, that all great conceptions arise and have arisen in times past, crudely at first it may be, but which, nevertheless, when reduced to order and embodied in works, have been of inestimable value to mankind. . . . The stimulus produced by alcoholic liquors, if not nearly of so high an order, is more easily called into play, while in a practical sense, the latent ability being present, it is more vigorous and effective as regards actual work. Hence the value of alcohol, as a stimulant, lies in the fact that it produces artificially and sustains temporarily that state of mental excitement or exaltation necessary to the conception and projection, though not to the detailed elaboration, of those enduring works that, whether in the domains of art, architecture, or engineering, are remarkable for boldness of execution, originality, and grandeur of design; and further, that it is the only manageable stimulant which, when used in moderation, and in the form of wine or spirits, is not only not injurious, but conduces to the general health, while it favors both mental and physical development." Dr. Sharpe also assigns to alcohol a beneficial agency in stimulating genial thoughts and feelings.

Japanese Lacquers.—The Japanese distinguish in lacquers between crude lacquer, which is obtained from the trunks of live trees and forms the basis of nearly all the mixtures used in making lacquer-ware; branch lacquer; and black lacquer, a preparation. The yield of branch lacquer is only about one per cent in comparison with that of other lacquers, while the proportion of ninety per cent is required in working. Hence a mixture is made of various kinds of lacquers, sea-weed jelly, finely grated sweet-potatoes, and as much soot as is needed to color the mass. Each manufacturer has his own special mixture, but the extraneous additions are believed not to injure the quality of the whole. True branch lacquer becomes extremely hard when dry; but, since when used alone it will not dry under some

twenty days, the pure sap is now but little used. The black lacquer is made by adding to crude or branch lacquer about five per cent of the tooth-dye used by women, a liquor formed by boiling iron filings in rice-vinegar, exposing to the sun, and stirring frequently for several days. In preparing all the lacquers it is an essential object to get rid of the water that exudes from the tree with the sap. This can not be effected without adding water, which is done in small quantities, three times a day, for two or three days. All the water then evaporates together. No lacquer will dry till this process has been gone through. If crude lacquer, which is originally of the color and consistency of cream, is exposed to the sun for a few days without adding water, it becomes black, or nearly so, thinner and translucent, but will not dry if applied to an article. If, now, water is mixed with it, it at once loses its black color and its transparency, becomes again of a creamy color, only slightly darker, and can be used after evaporation of the water, like any ordinary lacquer, and will dry. The greatest difficulty the lacquer-workers have to contend with is that of obtaining a clear, transparent varnish. What is called transparent varnish is really black to the eye, and has to be ground and polished after application before it will present a brilliant surface.

Superstitions about Stone Implements.—Richard Andrée, a German anthropologist, has remarked that, wherever prehistoric stone implements have been found, whether in Europe, Asia, Africa, or America, identical ideas, agreeing frequently in the minutest particulars, have been associated with them in the popular mind. It is really astonishing to find the negroes, the South American Indians, the Burmese, and the different European stocks entertaining the same superstitions respecting the origin and supposed wonderful properties of the stone axes. Such conceptions must be regarded as comparatively new, for they can only have originated after the implements had gone out of use, and the casual finding of them would be capable of exciting a mystified curiosity. They would naturally appear to the finders, who had no idea of their use, as something wonderful, perhaps having their origin in another world; and it would also be natural to attribute mysterious properties to them. The fall of meteoric stones would give a kind of a justification to such notions. People everywhere have thought the stone implements were the product of the lightning, or its bolts, and that the noise of thunder was caused by their striking the earth; and the belief is very common that the "thunder-axe," which is driven deep into the ground, will gradually rise to the surface again in the course of some definite period, as seven days, weeks, or years. The finder of one of these mysterious objects esteems it highly on account of the peculiar properties attributed to it, and transmits it to his posterity. Such stones are regarded as amulets in Asia and Europe, and as fetiches on the Guinea coast. They are believed to preserve one against harm, to prevent sterility in women, to give protection against fire and lightning; treasures are sought with them, and most effective medical properties are attributed to them. They have been believed to have a kind of life, and to sweat on the approach of a storm. These superstitions have no footing among people who are still in the stone age and acquainted with the use of stone implements. Thus, no trace of them is found in the South Seas and Australia; although a foundation for them appears to be laid among the West Australians, in the shape of a belief that certain smooth, oval stones have fallen from the sky.

A Subterranean River in Austria.—One of the recent publications of the Austrian Tourists' Club contains a description of the "Recca Cave," which it is claimed must be ranked among the greatest natural curiosities of the Austro-Hungarian monarchy. The cave is situated near the middle of the Karst mountain-land, in the bare and sterile plateau that spreads out above Trieste, in a region rich with caves, and has been formed by the flow of the Recca River under the cretaceous hills. Similar river-excavations are common in the region, but that made by the Recca surpasses all the others in extent. Near the railroad-station of Vistrica-Ternovo, the Recca is a stream some fifteen or twenty paces broad and two or three feet deep. Thence it flows along the border of the chalk and tertiary formations in a deep-

ly cut but pleasant valley, till it comes to a point where the chalk crosses its course in a semicircular range, and seems as if it would stop its further progress with a dam nearly four hundred feet high. The river has, however, conquered this wall by boring under it a tunnel fifty feet high and half as wide, through which it rushes in a very lively torrent. In the course of a little over a hundred yards, it passes a chimney-shaped shaft, which extends to the whole height of the mountain and presents an opening more than thirty feet in diameter at the surface. After another hundred yards the stream crosses the floor of a *doline* (or sink-hole) four hundred feet broad, and then, after crossing a narrow ledge, enters the great *doline* of St. Canzian. Here the steep, frequently impending rocks on three sides form a gigantic kettle, the western wall of which falls perpendicularly more than five hundred feet. On the southern side a turf-covered slope descends toward the bed of the river, to end abruptly in a precipice of nearly two hundred and fifty feet. Having twice bored the hills for relatively short distances, the Recca continues its course till it meets the rock-wall a third time and excavates a third subterranean channel, this time of thirty-five kilometres, or twenty-two miles. This is the Recca Cave proper, and from it the stream emerges near San Giovanni di Duino into the important river, though a short one, the Timavo, the mystery of the origin of which has been solved by this tracing of the course of its main affluent.

Scottish and Irish Crannogs.—Dr. Robert Munro, in his "Ancient Scottish Lake-Dwellings or Crannogs," draws a parallel between the island-fortifications of the western Celts and the lake-dwellings of Switzerland, and then suggests a connection of development between the crannog and the moated castle of the middle ages. "Crannog" is a Gaelic term, from *crann*, a mast or tree, and seems to point to the fact that wooden piles or tree-trunks formed an important part in the structure. While the crannogs have several features in common with the Swiss pile-dwellings, they exhibit also some important points of difference, whereas the Irish and Scottish structures are essentially similar. The latter were really fortified islands, sometimes natural, but generally artificial. When complete and in use, they would present the appearance of small islands surrounded by strong palisades for defense, with buildings of various kinds on their surface, dug-out canoes ready for use, and in some cases a causeway or gangway communicating with the shore. They were certainly built with great skill, and with a solidity of which the endurance of parts of them to the present time is the best evidence. Stone weapons have been found in the crannogs, but the bulk of the remains they yield are of bronze and iron, and some of the coins and pottery point to Roman influences. It is generally admitted that even the Irish crannogs are long subsequent in date to the earlier Swiss lake-dwellings. The crannogs, moreover, continued much longer in use than the corresponding lake-dwellings in Switzerland; those of Ireland down to the seventeenth century, those of Scotland to a century or two earlier. They were evidently used mainly for defense. In the more northern and wilder parts of Scotland the wooden structures gave way to stone castles, and in the end, as Dr. Munro points out, instead of the castle being brought to the water, the water was brought to the castle in the shape of a moat. It is certainly possible that some individual castles may be the direct representatives of former crannogs, but it would be very hard to prove that there has been, as Dr. Munro seems inclined to think, any general connection of the kind between the two structures.

Effects of Gases on Insects.—Mr. L. P. Gratacap reports, in the "American Naturalist," respecting experiments he has made upon the power of different insects to live in various gases. The Colorado beetle proved the hardiest of them; it was killed outright in the vapor of prussic acid, which it, however, stood longer than any other insect experimented with, while it was paralyzed for a time in illuminating gas, and died after two hours' imprisonment in nitrous oxide. The effects of oxygen were not very marked; hydrogen produced lethargy in flies, and was bad for snapping beetles, moths, and a wasp; carbonic acid killed flies at once, and threw Colorado beetles on their

backs; carbonic oxide killed ants, but not Colorado beetles; prussic-acid vapors and nitrous-acid fumes destroyed everything, as did chlorine everything but Colorado beetles; nitrous oxide exhibited but slight effects; and illuminating gas appeared to produce death if the exposure was long enough. Mr. Gratacap recommends charging from time to time with illuminating gas as probably, and charging with diluted prussic-acid fumes as certainly, an efficient preventive of the ravages of insects in cabinet cases.

Backsheesh in Arcadia.—"How much to be envied are you Singalese!" says Herr Haeckel, in his "Indian Letters of Travels." "You are not troubled either about the cares of to-morrow or of the distant future. What you require for your own life and your children's grows of itself at your mouth; and whatever else you may want in the way of luxury you can get with the slightest exertion. You are, indeed, like the lilies of the field, that grow around your simple huts; they sow not, neither do they reap, and still heavenly Nature feeds them. You are not excited with political or military ambitions; no anxious thoughts about business, or the rise and fall of stocks, disturb your sleep. The highest honors, titles, and orders of civilized men are unknown to you. Yes, I believe it fully, you do not envy us Europeans for our thousand superfluities; you are happy in being simple men, Nature-men, living in a paradise, and enjoying that paradise. Yes, what care-burdened civilized man would not envy you your simple condition, and your paradisiacal contentment?" A few moments after indulging in these reflections, Herr Haeckel reached the last post-station before arriving at Point de Galle, and was still thinking he had come upon a place where the struggle for existence had no being. His porters awakened him from his dream by speaking to him of their "backsheesh." It was now time to attend to that matter, for it might be forgotten, in the hurry and confusion, if it was put off till they got to the city. Herr Haeckel had remarked that a native gentleman had given each of the porters a "double anna," and reasoned that, in consideration of his superior distinction as a "white man," it would be proper to quadruple the amount and give a shilling. The porters returned the coins with irritation, and gave their patron a very flattering lecture about the distinction to which he was entitled by reason of his purely white skin. The main point which they presented was, that every white man ought to give double what he had given, or a rupee; but that as white a man as he was, with his light hair, must belong to the very highest caste, the dignity of which would be suitably maintained by a still larger gift. Without acceding to the full force of this complimentary argument, Herr Haeckel yielded so far as to give the full white man's backsheesh of a rupee to each man, and had the pleasure of hearing himself pronounced a perfect gentleman.

The Chinese Superstition of Severed Queues.—Dr. D. J. MacGowan, in a report on the health of Wenchow, has published some facts concerning "epidemic frenzies," or "popular crazes," which frequently prevail among large portions of the Chinese population. One of them raged very extensively in 1876, when it was believed supernatural agencies were at work cutting off the queues of the people. A sorcerer, getting possession, with the aid of a spirit, of one of these queues, was believed to be able thereafter to evoke at will the soul of the owner and use it as a servile demon, while the man was fated to die. The only remedy within the reach of a person who has lost his queue is to cut off an inch or more of what hair he has left and soak it for eighty days in a cesspool; by this means the mysterious connection between the hair remaining on his head and that in possession of the sorcerer is severed. Amulets and charms are, moreover, relied on for the prevention of disaster to the queue. A charm for this purpose was invented by the Governor of Kiang-Su, who also recommended an anathema attributed to Tao Tse, which was to be chanted while copying it on yellow paper with the blood of a cock mixed in vermilion, after which the paper was to be burned and the ashes swallowed. The panic was created by some revolutionists, who secretly cut off the queues of a few passers-by in each large city, and then proclaimed that a diabolical agency was at work.

The Pygmies.—Dr. Emin Bey gives in a recent number of Petermann's "Mittheilungen" some later notices of the Akkas, the pygmy race discovered in Africa, and first described by Schweinfurth. They are a hunting people, divided up into numerous tribes that do not mingle with one another. They have no fixed abodes, but wander around in the countries of the Monbuttc and the Amadi. When a small society of them sojourns temporarily around the settlement of some chief, they build little huts for the married ones, while the unmarried satisfy themselves with mere shelters from the sun. Usually they live in the groves that line the streams, which afford them game and good hiding-places. The chiefs provide them with grain and roots, and take their pay in the proceeds of the hunt. The Akkas are vengeful and dangerous when offended, and are skilled in the use of the bow and arrow. Emin Bey's measurements gave heights of between four and four and a half feet for full-grown Akkas. The color of their skin varies from a clear yellow to a glistening red. The whole body is covered with a thick, stiff, filthy growth of hair. A disposition of the skin to wrinkle, peculiarly observable in the eyelids, makes them look much older than they are.

Origin of Fires in London.—The statistics of fires in London for the thirteen years, 1870–'82, state the origin and nature of 22,262 fires, of which ten per cent attained serious proportions. The most fires were started in private houses, but they were the least dangerous ones, for only 2·4 per cent of them became serious, while in such establishments as saw-mills, furniture ware-rooms, rag-stores, and builders' shops, more than one fourth of the fires were destructive. No particular influence of seasons in promoting or diminishing the danger of fires appears from the London reports, where the difference in the number of outbreaks in the several months is comparatively small and irregular, but in agricultural districts the most fires seem to take place in July and August. According to the facts presented by Mr. W. G. McMillan, in a lecture before the Society of Arts, the distribution of fires over the hours of the day seems to be governed by a distinct and well-defined law. The curves illustrating the hourly distribution, through several years, show a remarkable symmetry and a wonderful agreement in general form. The most outbreaks occur between eight and nine in the evening, whence the numbers fall somewhat rapidly to a minimum at between six and nine in the morning. Thence the curves rise gradually to the evening maximum. By far the greatest number of the fires recorded originated in the use or abuse of light- and heat-giving apparatus. The most prolific source of danger still appears to be the candle, less dangerous than when the old-fashioned, spark-emitting tallow-candles were in use, but still operative by means of the ease with which it may be set under a shelf or carried within reach of light drapery. Surrounding the candles with tall shades like lamp-chimneys is recommended as a precautionary device. Petroleum is, with due precautions, a safe fluid, but there are other burning-fluids, and some kinds of petroleum, that are highly dangerous. Coal-gas is entirely safe, except from the danger of leaks at the joints of the pipes, which may be guarded against; but all burners should be fixed, else they may be carelessly brought within reach of drapery. Many fires are caused by carelessness in throwing away matches after they have been used. Directly and indirectly, artificial heating is responsible for a large proportion of fires. It operates through sparks shot out from open grates; through defects in flues; through the proximity of wooden beams and planks to flues, steam-pipes, or register-furnaces; and through carelessness in disposing of hot ashes. The red fire used in theatres is very liable to spontaneous combustion; plumbers sometimes allow their portable furnaces to set fires; and the sun shining through a body so shaped as to act as a lens to concentrate its rays, has been known to set papers on fire. Water is still the cheapest and most effective extinguisher; and other agents in use are good in their way. Gypsum, used as a plaster and in concrete, is an excellent fire-proofing material. Wood may be made uninflammable by painting it with asbestus; by impregnating its fibers with such substances as tungstate or silicate of soda, or

with two soluble substances which, coming together, will form an insoluble one. If wood is impregnated, too, with a substance capable of volatilization, its taking fire will be delayed till the volatile substance has been driven off. Warning of fires is automatically and surely given by means of devices by which the expansion of a column of mercury by the developed heat is made to close the circuit of a galvanic battery and sound an electric bell.

The Sunny Skies of Kamchatka.—M. Leonhard Stejneger has published in the Norwegian journal, "Naturen," a paper on the fauna and flora of Eastern Kamchatka and the Commander Islands, which adjoin our own Aleutian Islands. While the climate of the islands is foggy and their vegetation scanty, Kamchatka is represented as rejoicing in Italian skies, smooth seas, and a mild temperature. The flora is so exuberant that some species, which only grow to be three feet high in Norway, there attain the height of a man. Among them are the birch, alder, willow, and service-tree, whose berries as well as those of a honeysuckle are finely flavored, and well relished by the inhabitants. The flowers of the wild rose, rhododendron, potentillas, and taraxacum, might be mistaken for Norwegian species. The birds are also well represented, and one of them, a warbler, is distinguished by a plumage that suggests the tropics, and a voice comparable with that of the nightingale. The fauna is generally palæ-Arctic, and few American forms are found.

NOTES.

Mr. James Stevenson, of the United States Geological Survey, has discovered some new cave and cliff cities in which a few peculiar features have been observed. One of them is a village of sixty-five underground dwellings situated near the top of one of the volcanic foot-hills of the San Francisco Mountains in Arizona. A common roof was furnished for the whole community by the hardened surface stratum of the hill.

Mr. Herbert McLeod has determined, by experiments instituted for the purpose, that India-rubber is altered under the combined influence of light and oxygen—absorbing oxygen and becoming cracked—but not by either agent alone.

Last year included the fiftieth anniversary of the lucifer-match, which was first made, in England, by John Walker, of Stockton-on-Tees, and also at Vienna, in 1833. In 1847 the red amorphous phosphorus was substituted for the more dangerous, corroding, ordinary phosphorus.

Professor Cohn has called attention to the fact that bacteria were first seen two hundred years ago, by the Dutch microscopist, Leeuwenhoek, who, in 1683, gave to the Royal Society a description of "very little animals moving in a very lively fashion," which he had detected, with his instrument, in the white substance adhering to his teeth. His drawings are very correct, and have never been surpassed till within the last ten years.

Captain T. G. Een, a well-known Swedish explorer, died from heart-disease on the Congo, while on his way to join Mr. Stanley.

M. Fayal, directing engineer of the coal-mines of Commentry, France, has published an account of his discovery of coal at that place, which has preserved to the very center of the beds the histological structure of the plants from which it is formed. The preservation is said to have been so distinct that M. Renault has been able to make specific determinations of several species of the carbonized plants.

A great impulse has been given to fruit-growing within the last ten years. The area of land devoted to this purpose in England increased, between 1872 and 1882, 26,696 acres; while the importations of fruit from different countries increased from 1,218,668 bushels in 1871 to 4,045,690 bushels in 1882. Much of this fruit is used for making jam. The acreage of fruit-land in Canada has been largely extended within the last fifteen years, and great interest in the promotion of the industry is taken by the Government and the land-owners. In the United States, two million acres were under cultivation as apple-orchards in 1878, and the value of the products had increased in twenty years from $6,600,000 to over $50,000,000. The drying and the canning of fruits have become very prominent branches of industry.

The author of the work on "World-Life," recently reviewed in our pages, regrets that the book contains a number of errata, and desires us to announce that slips of corrections will be mailed to any who will kindly signify their desire to receive them. Address Alexander Winchell, Ann Arbor, Michigan.

M. Arthur Roche, Professor in the Lycée of Montpellier, France, who died a few months ago, was well known for his researches on the figures of planets and

comets and the cosmogonic theory of Laplace. He was the author of various memoirs on the equilibrium of a homogeneous fluid mass in rotation; on the effect, upon the figure of equilibrium, of attraction exerted by a center situated at a great distance; on the physical constitution and internal condition of the globe, in which he held that the density of the earth at the center is nearly double the mean density, and pronounced against the theory of the complete fluidity of the interior; on the figures of comets; and on the constitution of the solar system.

ARCHÆOLOGICAL investigations in the Afrosnab suburb of Samarcand have brought many interesting relics to light. Among them are marble ornaments, mosaics, and articles of bronze, clay, and glass, belonging to the Arabian, Græco-Bactrian, or old Iranian schools, all of which have in their time flourished at that place. Chinese coins have been found at a depth of three or four metres.

AT the December meeting of the Natural Science Association of Staten Island, New York, Mr. Hollick gave a description of the leaf-fossils which have been found at Tottenville. The fossils occur in three kinds of rock, all supposed to be cretaceous —a hard red or gray ferruginous sandstone, a soft gray sandstone, and a conglomerate composed chiefly of vegetable remains cemented with an oxide of iron. They are carbonaceous in the soft gray sandstone, only impressions in the other rocks. The rocks are found scattered, in blocks not more than a foot square, along the beach. The leaves are of willow, arbor-vitæ, viburnum, sourgum, grass, a small fruit or nut, an equisetum, and indistinguishable fragments. Similar sandstones with similar fossils occur near Glen Cove, Long Island. At the January meeting of the Association, Mr. C. W. Leng read a paper on the "Cicindelidæ" (beetles) of Staten Island, of which he distinguished eight species

NEW pests are appearing, to consume our apples. The apple-maggot (*Trypeta Pomonella*), leaving the outside of the apple fair to look upon, honey-combs its interior till nothing is left of it. The marauder is of a greenish-white color about one fifth of an inch long, and comes from a fly not unlike our house-fly, having whitish glassy wings, with dusky bands shaped somewhat like the letters IF. It comes from Illinois, where it feeds upon the hawberries, but has learned the merits of Eastern summer apples, and is said to be trying the virtues of later varieties. Information is wanted by Professor J. A. Lintner, State Entomologist, of New York, concerning its life-history, and all assistance that observers can give him in studying its habits and learning the best method of contending against it.

THE International Electrical Exhibition, to be held in Philadelphia under the auspices of the Franklin Institute, will open on the 2d of September and close on the 11th of October. The exhibits will be classified under seven heads or sections, viz.: I. Production of Electricity; II. Electric Conductors; III. Measurements; IV. Applications of Electricity (A, apparatus requiring currents of comparatively low power; and B, apparatus requiring currents of comparatively high power); V. Terrestrial Physics; VI. Historical Apparatus; and, VII. Educational and Bibliographical. The building will be opened for the reception of articles for exhibition on the 11th of August. Applications for space must be made before the 30th of August. Exhibitors are required to pay five dollars as entrance-fee, and space-charges for their exhibits in addition. Address Committee on Exhibitions, Franklin Institute, Philadelphia, Pa.

THE life-saving stations of the United States Signal Service are now designated by name, the former designation by numbers having been abandoned on the first day of June last. As the new names are for the most part descriptive, or refer to some locality in the immediate neighborhood, the identification of them is greatly facilitated to persons who are not connected with the service, while it is not made any harder to those who are connected with it. The circular of the Bureau gives, together with the names, exact descriptions of all the stations.

A REMARKABLE story of canine partiality is told in the English papers. Two men were out from Milford Haven in a boat, which was swamped. A dog, who was with them, caught one of them to help him out of his trouble, but, finding he was not his master, dropped him to drown, sought his master, and rescued him.

SUCCESSFUL experiments have been made at Coblenz, in Germany, into the practicability of substituting ravens for carrier-pigeons. Ravens, being stronger and bolder birds than pigeons, are less liable to be attacked and destroyed by birds of prey.

THE people of Doll, M. Pasteur's native village, have set up a memorial tablet in the house where the great microbe-hunter was born. M. Pasteur was present on the occasion of the inauguration of the monument, and made a short address.

M. E. PEYRUSSON has called attention to the danger following the use of delf-ware in cases of infectious disease. It is liable to be marred by cracks and flaws in which germs may lurk. Only glass or porcelain should be trusted.

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